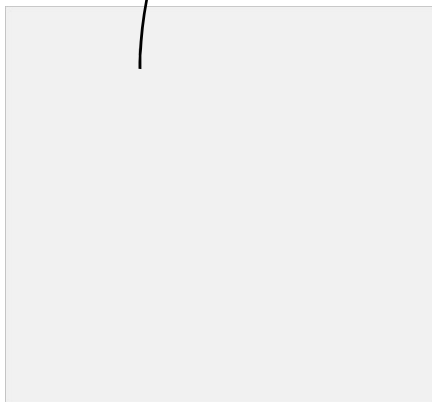


FURNITURE SPECS

EXECUTIVE OFFICE SPECIFICATION

ARCH FIRM: LEO A. DALY



Finish Tag: D-1

Manufacturer: Herman Miller

Style: intent

Color: Storage, Legs and Frame: Sandstone (WL), Worksurface: Soft White (LU), Tackboard: Marsh 5T22

*Top Photo for reference only. Contact Herman Miller Rep for complete specification

CITY OF HIALEAH, FLORIDA
REVERSE OSMOSIS WATER TREATMENT
DESIGN CRITERIA PACKAGE

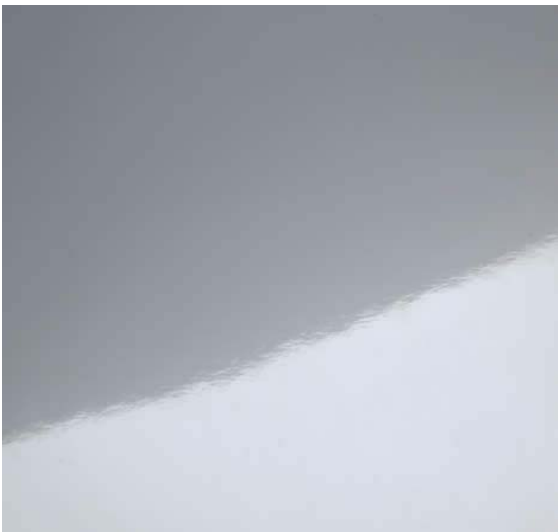
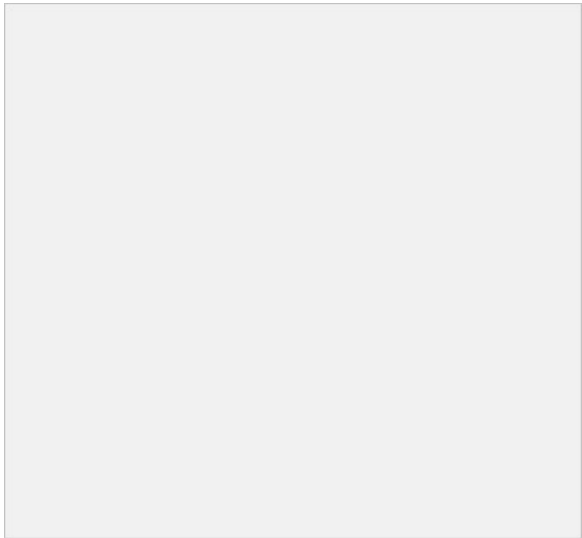


Approx. List Price: Starting at \$4,200 per workstation

FURNITURE SPECS

BREAKROOM TABLE

ARCH FIRM: LEO A. DALY



Finish Tag: CF-1
Manufacturer: Herman Miller
Style: CLT Tables
Top: Soft White LU, Frame/Legs: Chrome/Polished Aluminum
Approx. List Price: Starting at \$800

FURNITURE SPECS

CONFERENCE TABLE

ARCH FIRM: LEO A. DALY



Finish Tag: T-2
Manufacturer: Bretford
Style: Conference Table
Table top: Wood Veneer Natural maple (82), Base: Aluminum (AL)
Approx. List Price: Starting at \$9,000

FURNITURE SPECS

AV Credenza and Regular Credenza for Conference Room

ARCH FIRM: LEO A. DALY



Finish Tag: C-1

Manufacturer: Bretford

Style: AV Credenza and Hospitality Credenza

Table top: Wood Veneer Natural maple (82), Hardware: Aluminum (AL)

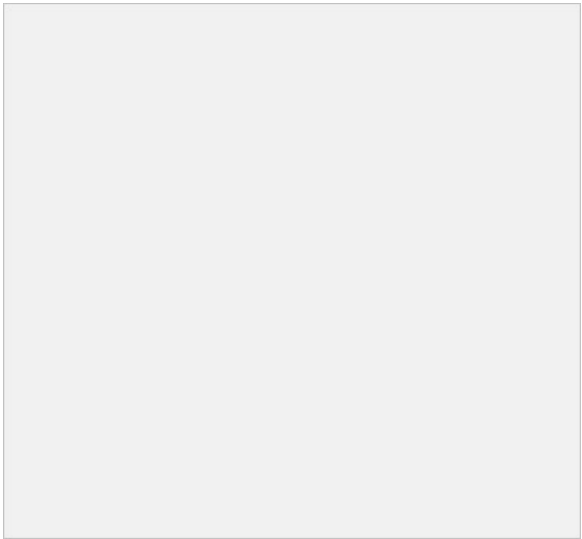
Approx. List Price: Starting at \$5,400 for Hospitality Credenza and \$6,100 for AV Credenza

CITY OF HIALEAH, FLORIDA
REVERSE OSMOSIS WATER TREATMENT
DESIGN CRITERIA PACKAGE

FURNITURE SPECS

FILE CABINET

ARCH FIRM: LEO A. DALY



Finish Tag: F-1
Manufacturer: Herman Miller
Style:Tu 4 Tier Filing Cabinet
Color: Formcoat Soft White LU
Approx. List Price: Starting at \$1,954

EQUIPMENT DATA SHEET

PROJECT NAME:	City of Hialeah Reverse Osmosis Water Treatment Plant	DATE:	8/31/09
SUBMITTAL:		ENGINEER:	
FACILITY NAME:		PROJECT NO.:	260363.09000
EQUIPMENT NAME:	Finished Water Storage Tanks		
IDENTIFICATION NO.:			
MATERIAL HANDLED:	Finish Water	# OF UNITS:	2 Initial – 1 Future
CAPACITY (Rate; Head)	5 MG		
MANUFACTURER; SIZE; CONFIGURATION:	135-ft diameter x 47-ft tall, Baffled tanks		
SPECIAL CONSTRUCTION MATERIAL:	Pre-stressed concrete		
COATINGS (Manuf. Std; Special):			
SEALS (Mech; Packing; Grease; Water):			
POWER REQUIRED (HP; Voltage; Phase):			
DRIVE (Elect, Var.-Mech., Var-Belt, Const-Belt, Va.-Direct, etc.):			
SPEED, RPM:	MAXIMUM:	MINIMUM	N/A
		:	
ALARMS:	INTERLOCKS:		
CONTROL:			
SUPPORT UTILITIES REQUIRED (Seal Water, Comp, Air, Drains, Etc.) (qty. if known):			

EQUIPMENT WEIGHT:	LBS/EACH	NOISE LEVEL:	N/A	dBa
-------------------	----------	--------------	-----	-----

MISCELLANEOUS COMMENTS, DATA AND INFORMATION (Vibration, Equipment Pads, Types, Sizes, Special Electrical, Structural, etc):

Accessories:

LOCATION OF EQUIPMENT:

Struct. Sht. No.:	P&ID Sht. No.:	HVAC Sht. No.:	Spec. Section:
Arch. Sht. No.:	Mech. Sht. No.:	Elec. Sht. No.:	

REVISION No.	REVISION DATE	REVISION DESCRIPTION	REVISION BY	APPROVED BY

ADDITIONAL COMMENTS:

EQUIPMENT DATA SHEET

Design Criteria for Storage and Transfer of Diesel Fuel for Back-up Generators

Unit Process	Design Standard
Estimated Design Capacity	8MW
Generators	
Rating (Estimated)	2.0MW, Standby
Number	4 (3 New, 1 Future)
Fuel Type	Diesel
Fuel Receiving Pump	
Minimum number	1
Capacity	Sized to fill a bulk storage tank in one (1) hour
Bulk Storage Tanks	
Type	Horizontal, double walled with leak detection
Total Capacity	Approximately 92,000 gallons, or capacity to operate entire facility on back-up power for a total of 7 days, 24 hours operation, plus 33% per NFPA 30
Fuel Transfer Pumps	
Minimum Number	1 per Generator
Capacity	Sized to fill a day tank in 30 min, minimum
Day Tank	
Minimum number (per Generator)	1
Type	Double Walled with leak detection
Capacity, each	830 Gallons, or capacity to supply one (1) generator for 6 hours operation
Piping	
Type	Double Walled with leak detection

Local Monitoring and Control:

- Bulk and Day Storage Tanks
 - Manual float/pulley inside exterior mounted site glass or other visual means of observing tank level from bulk fill station
 - Leak detection
 - Transfer/Receiving Pumps

Real Time Monitoring & Control:

- Discrete/status Alarm Displays
 - Bulk and Day Storage Tanks Low level

- Bulk and Day Storage Tanks High level
- Bulk and Day Storage Tanks High High level
- Bulk, Day and Piping Leak Alarm
- Transfer/Receiving pump status
- Analog Displays
 - Bulk and Day Storage Tank levels

The generators will be diesel engine type. The engine starter should be battery operated. The generator will be cooled by engine mounted radiator. Upon power failure of a station's normal power supply, a transfer switch will transfer power supply to the generator. The transfer of power will be automatic by sensing devices within the transfer switch. The generator can be manually started for exercising the unit.

SECTION 13320

SYSTEMS INTEGRATION REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.01 SCOPE

A. Requirements

Requirements specified in Division 1 of these Specifications form a part of Division 13. This Section covers the general requirements for furnishing and installation of the instrumentation, control and monitoring (ICM) system complete in every detail for the purposes specified and shall form a part of the other Sections of Division 13 unless otherwise specified. The other Sections of this Division shall supplement this Section as necessary. All work and documentation shall comply with all applicable local codes and ANSI and NFPA standards.

1. Work Included

- a. The intent of Division 13 is to require that the complete Instrumentation, Control and Monitoring System, including the other Sections of this Division shall be furnished by a single Control Systems Integrator (CSI) to assure system uniformity, subsystem compatibility and coordination of system interfaces.
 - b. Provide a complete and functional Supervisory Control and Data Acquisition (SCADA) system as described herein, as per the project specifications, and as shown on the drawings. The system is comprised of a Distributed I/O (DIO) and/or Remote I/O (RIO) with equipment required to tie it into a redundant fiber optic Ethernet IP network, servers and operator workstations for the plant. Field instrumentation shall interface to the network via Profibus DP and PA for valves, flow meters, pressure transmitters, and level transmitters. The SCADA system is to monitor and control all equipment. Materials, incidentals, software, supervision, and labor shall be provided under this contract.
 - c. Provide a means to tie the SCADA system monitoring and control to the City's existing SCADA system.
 - d. Furnish the tools, equipment, materials, and supplies and perform the labor required to complete the furnishing and installation of, including instrumentation signal and power conduit and wiring not specifically shown on the electrical drawings, validation, start-up and operational testing of a complete and operable ICM system as indicated on the Drawings and as specified herein.
 - e. Provide the equipment components, interconnections and the services of the manufacturers' engineering representatives for the engineering, implementation, startup, operation, and instruction, to insure that the City receives an integrated and operational ICM system as herein specified.
 - f. Coordinate with the requirements of Division 16 and provide for automatic restart of all equipment on restoration of loss-of-power condition. Sequence automatically equipment restart and provide for time delays as necessary to prevent breaker trips on inrush from multiple equipment concurrent starting.
2. As a minimum, the Instrumentation Subcontractor or vendor shall perform the following work:

- a. Implementation of the ICM system:
 - i. prepare shop drawing submittals
 - ii. design, develop, and electronically draft loop drawings and control panel designs
 - iii. prepare the test plan, the training plan, and the spare parts submittals
 - iv. procure hardware
 - v. fabricate panels
 - vi. program the ICM system as shown on the Drawings
 - vii. perform factory tests on panels
 - viii. perform bench calibration and verify calibration after installation
 - ix. oversee and certify installation
 - x. oversee, document, and certify loop testing
 - xi. oversee, document, and certify system commissioning
 - xii. conduct the performance test
 - xiii. prepare operations and maintenance manuals
 - xiv. conduct training classes
 - xv. prepare record drawings
 - xvi. prepare calibration sheets
 - xvii. certify the installation of the ICM system
 - b. Integration of the ICM system with instrumentation and control devices being provided under other Sections:
 - i. Develop all requisite loop drawings and record loop drawings associated with equipment provided under other Divisions.
 - ii. Resolve signal, power, or functional incompatibilities between the ICM system and interfacing devices.
3. Work Not Included
- a. Process piping, installation of in-line instrumentation, i.e., final control elements in process pipelines, air compressors, main air supply headers, and mechanical work as specified in other Divisions.
 - b. Electrical power distribution specifically included under Division 16, circuit protection devices, power conduit and wiring indicated, local equipment control stations, and miscellaneous electrical requirements as specified in Division 16.

B. System Responsibility

- 1. The ICM system as specified in this Division is an integrated system and therefore shall be provided by a competent, qualified CSI who shall have total responsibility for the work of this Division. Entire system installation including calibration, validation, start-up, operational testing, and training shall be performed by qualified personnel, possessing all the necessary equipment and who have had experience performing similar installations. The System shall be integrated using the CSI's latest, most modern proven design and shall, as far as practical, be of one manufacturer.
- 2. The Company shall subcontract the work under this Division to a qualified CSI who shall perform said work but it shall be understood that this shall not relieve the Company from any responsibility under the Company.

3. The Company shall be responsible for the correct installation of all hardware and systems specified in this Division.
4. The Company shall be responsible to see that all components of the instrumentation system, including primary measuring, indicating, transmitting, receiving, recording, totalizing, controlling, alarming devices and appurtenances are compatible and shall function as outlined, and he shall furnish and install such additional equipment, accessories and appurtenances as are necessary to meet these objectives at no additional cost to the City.
5. The Company shall use the instrument tag and equipment numbering scheme as shown on Company Documents, for identifying components which are part of this system.
6. Due to the complexities associated with the interfacing of numerous control system devices, the CSI or vendor shall be responsible to the Company for the integration of the ICM system with existing devices and devices provided under other Sections and provide a completely – integrated control system free of signal incompatibilities; this includes providing review and comment to other vendor equipment submittals and overall coordination of the system.

C. Certification of Intent:

1. Fifteen days after notice to proceed, the Company shall submit a certification from the selected CSI or vendor. The certification shall be typed on letterhead paper of the CSI or vendor firm. The certification shall be signed by an authorized representative of the CSI or vendor. The certification shall include the following statements:
 - a. (Company name) "hereby certifies intent to assume and execute full responsibility to the Company to perform all tasks defined under Specification 13000, Section 1.01 Scope, in full compliance with the requirements of the Company Documents."
 - b. "It is certified that the quotation to the Company includes full and complete compliance with the requirements of the Company Documents without exception."

D. Documentation of Instrumentation Subcontractor Qualifications:

1. List of at least two instrumentation and control system projects successfully completed, of size and scope similar to that described herein, in which the applicant performed system engineering, system fabrication and installation, documentation (including schematic, wiring and panel assembly drawings), field testing, calibration and start-up, operator instruction and maintenance training. Each of the references cited must be accompanied by a written confirmation of the accuracy of the data by a managerial member of the control system operational staff.
2. In addition, list the following information for each project above:
 - a. Name of plant, City, contact name and telephone number. All phone numbers and contacts shall be verified by the applicant before submission.
 - b. Name of manufacturer(s) for the majority of instrumentation provided.
 - c. Type of equipment furnished (i.e., transmitters, recorders, indicators, etc.)
 - d. Manufacturer and model number of DCS, SCADA, or PLC to which the system interfaced.
 - e. Date of completion or acceptance.
3. Furnish the name of the individual person who will be responsible for engineering and management of this project, and the individual who will be responsible for field testing, calibration, start-up, and operator training for this project. Include references of recent projects of these individual persons.

4. Submit specific documentation which verifies that CSI employs the minimum of individuals who have been formally trained in the application of the:
 - a. Indicated operating systems.
 - b. Indicated software packages.
 - c. Indicated graphical user interface software packages.
5. Document that the applicant's company has been actively involved in the instrumentation systems business (under the same corporate name).

E. Company Drawings

1. Information on the Drawings

- a. The following information relative to the work of this Division is indicated on the Company Drawings.
 - i. Location of primary elements, control panels, and final control elements.
 - ii. Instrumentation signal and power conduit runs between control panels and field instruments and devices.
 - iii. Quantity and sizes of instrumentation conductors and cables are indicated on the drawings, but shall be verified by the Company.
 - iv. Location of all equipment having alarm and equipment status contacts.
 - v. Major instrument conduit runs.
 - vi. General control room layout

2. Information Not on the Drawings

- a. The following information relative to the work of this Division may not be shown on the Drawings, but shall be the responsibility of the Company to determine, furnish, coordinate with other Trades, and submit for approval, based upon the systems specified.
 - i. Tubing for pneumatic signals, and/or power between main headers and control panels, field mounted primary elements, field instruments and final control elements.
 - ii. Number or sizes of tubing required for pneumatic and hydraulic signals.
 - iii. Point of connection to any hydraulic or pneumatic supply lines.

1.02 STANDARDS

A. American National Standards Institute (ANSI)

1. ANSI/ISA-S5.1-1984 (R1992)

B. National Fire Protection Association (NFPA)

1. NFPA 70 National Electric Code (NEC)

1.03 SUBMITTALS

A. General.

Refer to the Design Documents for required method of preparation and transmittal and conform to requirements herein.

1. Pre-submittal Conference

- a. Arrange a conference with CSI, the City Engineer, and the City within thirty (30) days after award of the Company for the purpose of informally discussing in detail and verifying the correctness of the CSI's system engineering methods and equipment and to generally provide a framework for communication and coordination. This conference shall be attended by CSI, and duly authorized representatives of the Company and City.
- b. Submit 4 copies of the following items for discussion at the Pre-submittal Conference:
 - i. A list of equipment and materials required for the ICM system and the manufacturer's name and model number for each proposed item. Identify items by tag number, description, function, manufacturer, model number, descriptive literature and statement as to whether item is "as specified" or "equivalent." Items identified as "equivalent" shall be accompanied by a comparative listing of the published specifications for the item specified and for the item proposed. Equivalent items shall only be accepted by the City if the specified item is no longer manufactured.
 - ii. A list of proposed clarifications to the Company Documents along with a brief explanation of each. Resolution shall be subject to a separate formal submittal and review by the City Engineer.
 - iii. A sample of each type of submittal specified herein.
 - iv. A flow chart showing the steps to be taken in preparing and coordinating each submittal.
 - v. A bar-chart type schedule for all system related activities from the Pre-submittal Conference through start-up and training. Dates of submittals, design fabrication, programming, factory testing, deliveries, installation, field testing, and training shall be shown. The schedule shall be subdivided to show activities relative to each major item or group of items when everything in a given group is on the same schedule.
 - vi. An overview of the proposed training plan. The City Engineer will review the overview and may request changes. All changes to the proposed training shall be resolved at the Pre-submittal Conference. The overview shall include the following for each proposed course:
 - a) Course title and objectives.
 - b) Prerequisite training and experience of attendees
 - c) Course content – a topical outline.
 - d) Course duration
 - e) Course format – lecture, laboratory demonstration, etc.
 - vii. A preliminary copy of the Instrumentation Subcontractor Qualification submittal.
- c. Take minutes of the Pre-submittal Conference, including all events, questions, and resolutions. Before adjournment, all parties must concur with the accuracy of the minutes and sign accordingly.

B. Shop Drawings

Before proceeding with any manufacturing, submit Shop Drawings for approval in complete bound sets indexed by specification number. Describe the items being submitted. Manufacturer's specification or data sheets shall be clearly marked to delineate the options or styles to be furnished. Submit only complete systems, not pieces of equipment from various systems. Show dimensions, physical configurations, methods of connecting instruments together, mounting details, and wiring

details, and wiring schematics. Schematics shall be complete with tag and terminal numbers. Submit fabrication drawings, nameplate legends, and control panel internal wiring and piping schematic drawings clearly showing equipment and tag numbers on panels. Submit panel graphic drawings where applicable. Include material specifications lists where applicable. Include a draft of the theory of operation for relay logic circuits including those implemented via programmable controllers. Submit detailed field instrument installation drawings for each instrument.

C. Design Related Submittals

1. In accordance with the requirements of Division 1, provide the following submittals:
 - a. Catalog Cuts
 - i. Catalog information, descriptive literature, wiring diagrams, and shop drawings shall be provided for all devices, whether electrical or mechanical, furnished under this Section. This includes, but is not limited to, primary elements, transmitters, analytical equipment, gauges, valves, controllers, indicators, power supplies, switches, lights, relays, timers, etc.
2. Component Data Sheets
 - a. Data sheets, specification sheets, and an instrument list shall be provided for components provided under this Section. The purpose of this material is to supplement the generalized catalog information by providing the specifics of each component (e.g., part numbers, scales, ranges, service, materials of construction, component location, options, and the individual tag number as noted in the Drawings and Specifications.
 - b. Include such other necessary data as would provide a complete and adequate specification for reordering an exact duplicate of the original item from the manufacturer at some future date. More than one tag numbered item may be included on a sheet.
3. Sizing Calculations
 - a. Complete sizing calculations shall be provided for all flow elements. The calculations shall include the process data used, minimum and maximum values, permanent head loss and all assumptions made. Equations shall be submitted for all computing modules and function generating modules and shall include the actual scaling factors and units used.
4. Panel Construction Drawings
 - a. Shop Drawings and Catalog Cuts
 - i. Provide detailed shop drawings and catalog cuts for panels, instrument racks, and enclosures. Drawings shall show the location of front panel and internal sub-panel mounted devices to scale and shall include a panel legend and bill of materials. Layout drawings shall show major dimensions as well as elevations, in inches from the base up, of the rows of components.
 - ii. Shop drawings shall indicate location and size of available spare mounting space for rear-of-panel devices. See Section 13200 – Control Panels.
 - iii. The panel legend shall list and identify front of panel devices by their assigned tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
 - iv. The bill of materials shall include devices mounted within the panel that are not listed in the panel legend, and shall include the device tag number, description, manufacturer, and complete model number.

- b. Color Schedule
 - i. Provide a color schedule with color samples for control panels for the City's selection/approval.
- 5. Power Requirement and Heat Dissipation
 - a. Provide a summary of the power requirements and heat dissipation for control panels. Power requirements shall state required voltages, currents, and phase(s) Heat dissipations shall be maximums and shall be given in BTU/Hr. Summary shall be supplemented with calculations.
- 6. Panel Wiring Diagrams
 - a. Wiring diagrams shall be similar to those diagrams shown in the Company Drawings, but with the addition of all auxiliary devices such as additional relays, alarms, fuses, lights, hand switches and interlocks.
 - b. Provide complete terminal identification of external primary elements, panels, and junction boxes that interface directly to the panel wiring being shown. Polarity of analog signals shall be shown at each terminal.
 - c. External wiring that the electrical contractor must provide and wire shall be shown as a dotted line. Special cables that are provided with the instrument shall be clearly identified.
 - d. Panel wiring diagrams shall identify wire numbers and types, terminal numbers, and tag numbers. Wiring diagrams shall show each circuit individually. Common or typical diagrams shall not be allowed.
 - e. Provide panel power wiring diagrams for panels. The diagrams shall include grounding requirements.
- 7. Interconnecting Wiring Diagrams
 - a. Diagrams shall show component and terminal board identification numbers, external wire and cable numbers. The drawings shall show intermediate terminations between field elements and panels (e.g., terminal junction boxes) This diagram shall be coordinated with the Company and shall bear his mark showing that this has been done.
- 8. Loop Diagrams
 - a. Provide an individual wiring diagram for each analog loop showing terminal numbers, the location of the DC power supply, the location of any dropping resistors, the location and connection of the surge protection devices. The loop diagrams shall meet the minimum requirements of ISA S5.4 plus the following requirements:
 - b. Each loop diagram shall be divided into three areas for identification of device locations: panel face, back-of-panel, and field respectively. Each loop diagram shall list (1) Transmitter Drive Capability, (2) Loop Impedance, (3) Transmitter Reserve Drive Capability. Loop diagrams shall be on 11-inch by 17-inch Drawings.
- 9. Instrument Installation Details
 - a. The CSI shall review the Company Documents and develop and submit for review, complete installation details for each field mounted device and panel prior to shipment and installation. Common details, not requiring any modification, may be referenced by an index showing the complete instrument tag number, service, location, and device description. Installation details shall be provided as required to adequately define the installation of the ICM system components.

10. Operator Interface Submittal

- a. This submittal shall cover the specific plant control schemes as well as the details of the plant reports and process graphic displays.
- b. The submittal shall contain the semi-final details of all logs, reports, and process graphic displays. The specifics of what shall appear on each display and what calculations are required to support them shall be developed and submitted.
- c. Submitted process graphic displays shall be no smaller than 8.5 inches by 11 inches and in full color.
- d. A complete listing of all signals to be collected for long term historical information shall be provided. This listing shall also include frequency of data sampling and duration for which the data shall be immediately accessible.
- e. A complete listing of all signals to be collected for trend display shall be provided. This listing shall also include frequency of data sampling and duration for which the data shall be immediately accessible.

11. Process Control Strategy Submittal:

- a. The process control schemes shall be developed in a ladder logic diagram or functional block (logic) diagram presentation based on information from the Specifications. Included with each diagram shall be:
 - i. Brief Scope of the Control Function.
 - ii. Listing of all scanned inputs to the control function.
 - iii. A short narrative of the control strategy
 - iv. Any assumptions made in developing the program
 - v. Listing of all inputs and outputs (i.e., AI, DI, AO, DO) from the control function.
 - vi. Cross reference list of all I/O showing to which I/O modules or software modules they are linked.
 - vii. Listing of all operator inputs/outputs to and from the control function. Any special CRT displays related to the function shall be illustrated. A description of the operation of any panels shall be described as it relates to the control function.
 - viii. Failure contingencies shall be described in detail.
 - ix. A flowchart representing the control strategy.
- b. This submittal shall cover all of the associated logic developed under this Company required to implement the control functions specified.
- c. The System Integrator shall submit annotated logic on 8-1/2 x 11" format and as an ASCII file on compact diskettes for all logic developed. Annotation shall be 3 lines of 6 characters each for every logic contact. In addition, each network or rung shall be annotated so that a non-technical person can read and easily comprehend what control function the rung or network is performing.
- d. This submittal shall also include copies of the PLC I/O configuration tables, I/O reference usage table, complete cross reference to specific rung used of all inputs, outputs, internal coils, data registers, and special purpose coils. In addition, any special switch settings or hardware configuration requirements such as com port configurations shall be described in detail and submitted.

D. Test Related Submittals

Provide five (5) copies of the following:

1. Operational Field Acceptance Test (OAT) Documentation

The CSI shall submit an example of each type of Instrument Calibration Sheet and Loop Status Report that will be used for the OAT.

After approval of the examples, the CSI shall prepare Loop Status Report Sheet(s) for each loop and an Instrument Calibration Sheet for each active ICM system element (except simple hand switches, lights, etc.) These sheets shall be submitted after the tests are completed.

a. Instrument Calibration Sheets

- i. Provide a written report to the City Engineer on each instrument certifying that it has been calibrated to its published specified accuracy. This report shall include all applicable data as listed below plus any defects noted, correction action required, and correction made. Data shall be recorded on prepared forms and shall include not less than the following items:
 - a) Facility identification (Name, location, etc.)
 - b) Loop identification (Name or function)
 - c) Equipment tag and serial numbers.
 - d) Scale Ranges and units.
 - e) Test mode or type of test.
 - f) Input values or settings.
 - g) Expected outputs and tolerances
 - h) Actual readings at 10, 50, and 90 percent of span.
 - i) Explanations or special notes as applicable.
 - j) Date, time, and weather.
 - k) Tester's certification with name and signature.

2. Functional Acceptance Test Documentation.

The CSI shall prepare two types of test procedures and forms as follows.

a. Loop Test Documentation

For functions that can be demonstrated on a loop-by-loop basis, the form shall include:

- i. Project Name.
- ii. Loop number.
- iii. Loop description.
- iv. Test procedure description, with a space after each specific test to facilitate sign off on completion of each test.
- v. For each component: tag number, description, manufacturer, and data sheet number.
- vi. Space for sign off and date by the ICM, the Company and the City Engineer.

b. Functional Test Documentation

For those functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:

- i. Specification page and paragraph of function demonstrated
- ii. Description of Function
- iii. Test procedure description
- iv. Space after each specific test to facilitate signoff on completion of each test.

E. Testing

1. Factory Testing

- a. Unwitnessed Factory Testing. Prior to the arrival of the City and/or City Engineer, each panel shall have been completely tested by the manufacturers personnel. Provide report certifying the control panels are operable and meet the Specifications. If upon arrival of the City and/or City Engineer, the panel(s) tests have not been performed, the Company shall be liable for back charges for extra time required for the City and/or City Engineer's services. The necessary panel tests shall be repeated in the presence of the City Engineer; the City Engineer shall have the right to check all test observations. The CSI shall demonstrate, on a spot check basis, that the results of the unwitnessed Factory Tests are accurate. As a minimum, tests shall verify the following:
 - i. Accuracy of panel instruments for 4-20 mA inputs and outputs.
 - ii. Location of interface wires on terminal blocks.
 - iii. Function of discrete panel components
- b. Witnessed Factory Testing. Inspection and test of materials and equipment shall be made by the City and City Engineer (or his representative) at the place of manufacturer prior to shipment, to verify that the completed control panel(s) meets the requirements of the specifications. Shipment shall not be made until receipt of written approval from the City Engineer after satisfactory completion of shop tests.
- c. The manufacturer furnishing materials, equipment and labor for the fabrication of the panel(s) shall afford the necessary facilities for such shop inspection and tests. The Company shall give the City and/or City Engineer written notice three (3) weeks prior to the estimated date when the equipment will be ready for the inspection and witnessed shop test.
- d. Sufficient time, ample space and necessary assistance shall be provided by the manufacturer to assure inspection and testing to the satisfaction of the City Engineer.
- e. The CSI shall furnish the power, labor, materials, and properly calibrated instruments required for the shop tests.
- f. The City Engineer reserves the right to reject defective materials, poor workmanship and items that are not in accordance with the requirements of the specifications.

2. Operational Field Acceptance Testing

- a. Installation Supervision
 - i. Furnish the services of authorized factory personnel specially trained and experienced in the installation of the equipment to: (1) supervise the installation in accordance with the approved Instruction Manual; (2) be present when the instruments and equipment are first put into operation; (3) inspect, check, adjust as necessary, and approve the installation; (4) calibrate the instruments, in accordance with the

with the Specifications herein, until all trouble or defects are corrected and the installation and operation are acceptable.

b. Instrument Calibration

- i. Provide the services of factory trained instrumentation technicians, tools and equipment to field calibrate each instrument to its specified accuracy in accordance with the manufacturer's specifications and instructions for calibration. Each instrument shall be calibrated at 10 percent, 50 percent and 90 percent of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 10 times greater than the specified accuracy of the instrument being calibrated.
- ii. Provide a list and basic specifications for instruments used for calibration.

c. System Validation

- i. Provide the services of factory trained and field experienced instrumentation engineer(s) to validate each system to verify that each system is operational and performing its intended function within system tolerance. System tolerance is defined as the root-mean-square sum of the system component published specified accuracies from input to output.
- ii. Validate the system by simulating inputs at the first element in each loop of 10 percent, 50 percent and 90 percent of span, or on/off and verifying loop output devices (i.e. recorder, indicator, alarm, except controllers) During system validation, make provisional settings on levels, and alarms. Verify controllers by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point. Verify that logic sequences operate in accordance with the specifications.
- iii. Cause malfunctions to sound alarms and/or switch to standby to check system operation. Check systems thoroughly for correct operation. Test equipment for this function shall be as specified under "Instrument Calibration."
- iv. Immediately correct defects and malfunctions disclosed by tests. Use new parts and materials as required and approved and retest.
- v. Provide a report certifying completion of validation of each instrument system. This report shall indicate calculated system tolerances, data verifying that the system meets these tolerances, and any provisional settings made to devices. Data sheets shall be similar to those used for calibration.

d. Company's Certified Reports

- i. Upon completion of all testing, the CSI, or its authorized representative, shall submit a certified report for each control panel and associated field instruments certifying that the equipment (1) had been properly installed under its supervision, (2) is in accurate calibration, (3) was placed in operation in his presence, (4) has been checked, inspected, calibrated, and adjusted as necessary, (5) has been operated under maximum power variation conditions and operated satisfactorily, and (6) is fully covered under the terms of the guarantee.

3. Final Acceptance Testing

- a. Upon completion of instrument calibration and system validation, test systems under actual process conditions in the presence of the City Engineer. The intent of this test is to demonstrate and verify the operational interrelationship of the instrumentation systems. This testing shall include, but not be limited to, specified operational modes, taking process variables to their limits (simulated or process) to verify alarms, failure interlocks,

interlocks, and operational interlocks between systems and/or mechanical equipment.

- b. Testing shall be observed by the City and/or City Engineer. Notify the City and/or City Engineer in writing a minimum of 48 hours prior to the proposed date for commencing the test. Upon completion of this test the Company shall begin or have begun system start-up. City and/or City Engineer reserves the right to set the schedule.
 - c. Submit for approval not later than 30 days prior to the final acceptance test demonstration, a written plan for demonstrating that each system of equipment provided under Division 13 meets the specified operational requirements.
 - d. The plan shall detail procedures to be used in final acceptance testing of applicable systems. The plan shall including a description of test methods and materials utilized for testing each system.
 - e. Immediately correct defects and malfunctions with approved methods and materials in each case and repeat the testing.
 - f. Submit three copies of test results and records for all final acceptance tests.
 - g. Upon completion of final acceptance testing, submit certified report, with substantiating data sheets, indicating that total ICM System meets all the functional requirements specified herein. The City and/or City Engineer will countersign this report and it shall constitute final acceptance of the ICM System.
4. System Commissioning Assistance
 - a. Provide the services of a factory trained and field experienced instrumentation engineer to assist City's personnel during each startup of the various systems. Purpose of this assistance is to support in making final adjustments of settings on the instrument systems.

F. Operation & Maintenance Manuals.

Furnish Instruction Manuals and Parts Lists for instrumentation equipment in accordance with the requirements of Division 1 and as noted herein.

1. Schedule
 - a. Deliver manuals not later than the equipment shipment date. After installation is complete, update the manuals to reflect any changes which occurred during installation and deliver balance of manuals to City Engineer.
2. Material Content. Include in the manuals not less than the following applicable information for each instrument, equipment, subsystem and/or control loop. The O&M Manuals shall consist of, at least, the following material:
 - a. Bill of Materials
 - i. A listing of all the panels, racks, instruments, components, and devices supplied. Components shall be grouped by component type, with the component types identified in a similar manner to the component identification code used in these specifications. The list shall contain, as a minimum:
 - a) Instrument, panel, rack or device tag number
 - b) Description
 - c) Quantity supplied
 - d) Reference to component data sheet and/or catalog cut
 - e) Component type
 - b. Component Data Sheets

- i. See 1.02 B.2 specified herein before.
- c. Catalog Cuts
 - i. See 1.02 B.1 specified herein before.
- d. Component O&M Manuals
 - i. An O&M manual shall be submitted for instruments and devices supplied. The O&M manuals shall contain, as a minimum:
 - a) Operating procedures
 - b) Installation procedures
 - c) Maintenance procedures
 - d) Troubleshooting procedures
 - e) Calibration procedures
 - f) Internal device schematics and wiring diagrams
 - g) Shut-down procedures
 - h) Component parts list
 - i) Detailed circuit operational description including annotated programmable controller ladder diagrams.
- e. Spare Parts and Expendables List
 - i. The spare parts and expendables list shall include not only those items supplied, but also the additional items recommended for successful long term operation.
- f. "As-Shipped" Drawings
 - i. Drawings shall be a record of work "As-Shipped" from the factory and shall be labeled as "As-Shipped". One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder. Provide the following "As-Shipped" drawings as a minimum:
 - a) Panel Fabrication Drawings.
 - b) Panel Wiring and Interconnection Drawings.

G. Final Record Documentation's

1. Reproducible Drawings. Company shall submit reproducible's of finished schematics, wiring diagrams and installation drawings to include installed field and panel instruments, mounting details, point to point diagrams with a cable, wire, and termination numbers. Drawings shall be a record of work as actually constructed and shall be labeled as "RECORD DOCUMENTS." One copy of applicable schematics and diagrams shall be placed in each control panel in a protective envelope or binder.
 - a. Loop Diagrams
 - 1) See 1.02 B.8 specified herein before.
 - b. Panel Fabrication and Wiring diagrams
 - 1) See 1.02 B.4 and 1.02 B.6 specified herein before.
 - c. Interconnecting Wiring Diagrams
 - 1) See 1.02 B.7 specified herein before.
 - d. Instrument Installation Details
 - 1) See 1.02 B.9 herein before.
2. Process and Instrumentation Diagrams (P&ID's)

- a. The City Engineer will supply the Company with P&ID's on magnetic media for revisions to reflect the final installed system.
 - b. The P&ID's shall be updated by the Company who may use these drawings for producing the final documentation.
3. Software Documentation. In addition to the reproducible hard copy of drawings and literature generated specifically for the project, Company shall submit CD-ROM's to the City Engineer with a copy of all custom files specifically created to generate the drawings, data sheets, bill of materials, operating procedures etc. Drawing format shall be compatible with AutoCad ver. 2009 or newer. Disks shall be clearly identified by the following:
 - a. Project Name
 - b. Volume Number
 - c. Software Program Name and Version used to generate the files.
 - d. Labeled "RECORD DOCUMENTS"

H. Training Requirements

1. General:
 - a. Provide the services of a factory trained and field experienced instrumentation engineer to conduct group training of City's designated personnel in the operation of each instrument system. Obtain City's written consent that the training has been adequate. Include instruction covering basic system theory, operating principles and adjustments, routine maintenance and repair, and "hands on" operation. The text for this training shall be the P & ID's, graphic operation interface, PLC and SCADA software, panel wiring diagrams and layouts, and the operation and maintenance manuals furnished under these Specifications.
2. Duration:
 - a. Training specific to the system control panel hardware and software. This training shall be for a minimum time period of 30 8-hour days and 6 trips. This training shall be separate from start-up and testing. See Section 01664 – Training.
3. Operator Training:
 - a. Operator training shall include instruction in the use of Control Panels and Field Panels furnished.
4. Maintenance Training:
 - a. Maintenance training shall include instruction in the calibration, maintenance, and repair required for all instruments.

I. Post-Company System Support

1. Maintenance Company:
 - a. Duration
 - i. Provide a 1 year maintenance contract for components furnished starting from the date of acceptance.
 - b. Schedule
 - i. Develop a program of preventive maintenance visits that includes verification of instrument performance on a monthly basis and complete calibration of instruments on a semi-annual basis. After every visit, submit to the City records of instrument verification and calibration on appropriate forms.

J. Guarantee And Warranties

1. Guarantee the work of Division 13 in accordance with the Conditions of Company and Division 1. With respect to instruments and equipment, guarantee shall cover (a) faulty or inadequate design; (b) improper assembly or erection; (c) defective workmanship or materials; and (d) leakage, breakage, or other failure not caused by City misuse. For equipment bearing a manufacturer's warranty in excess of one year, furnish a copy of the warranty to City Engineer with City named as beneficiary.

PART 2 - PRODUCTS

2.01 HARDWARE REQUIREMENTS

A. Job Conditions

1. Drawings are diagrammatic and show the intended arrangement for system operation, piping, and appurtenances. Conform to Drawings as closely as possible and exercise care (1) to secure neat arrangement of piping, valves, conduit, and like items, and (2) to accommodate structural features. Verify dimensions and conditions at the place of work, and install materials and equipment in the available spaces.

B. Materials and Standard Specifications

1. Provide instruments, equipment and materials suitable for service conditions and meeting standard specifications such as Instrument Society of America (ISA). The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the facilities, instruments supplied by the Company, of the same type shall be by the same manufacturer. All panel mounted instruments shall have matching style and general appearance. All meters, instruments, and other components shall be the most recent field-proven models marketed by their manufacturers at the time of submittal of the shop drawings unless otherwise required to match existing equipment. This allows the stocking of the minimum number of spare parts.

C. Product Delivery, Storage, and Handling

1. Box, crate, or otherwise enclose and protect instruments and equipment during shipment, handling, and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids and gases or any element which could degrade the equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repair any damage as directed and approved.

D. Mountings

1. Mount and install equipment as indicated. Where not shown, mount field instruments according to best standard practice on pipe mounts, pedestal mounts, or other similar means in accordance with suppliers recommendation. Unless specified otherwise all mounting hardware shall be stainless steel. Where mounted in control panels, mount according to manufacturer recommendations.
2. Equipment specified for field mounting shall be suitable for direct pipe mounting, pedestal mounting, or surface mounting. Non in-line indicators and equipment with calibration adjustments or requiring periodic inspection shall be mounted not lower than three (3) feet nor higher than five (5) feet above walkways, platforms, and catwalks. Such equipment shall be weather and splash proof, and corrosion resistant and electrical equipment shall be in 316SS

316SS NEMA 4X cases unless otherwise noted.

E. Instrument Identification

1. Components provided under this Section, both field and panel mounted, shall be provided with permanently mounted name tags bearing the entire ISA tag number of the component. Panel mounted tags shall be plastic; field mounted tags shall be stamped stainless steel.
2. Nameplates for panels and panel mounted equipment shall be as specified under Section 13200 – Control Panels.
3. Field mounted tags shall be 16-gauge, 304 stainless steel with 3/16 inch high characters.
4. Tags shall be attached to equipment with a commercial tag holder using a stainless steel band with a worm screw clamping device or by a holder fabricated with standard stainless steel hose clamps and meeting the same description. In some cases where this would be impractical, use 20 gage stainless steel wire.
5. For field panels or large equipment cases use stainless steel screws, however, such permanent attachment shall not be on an ordinarily replaceable part. In each case, the tag shall be plainly visible to a standing observer and not obscure adjustment ports or impair the function of the instrument. Field mounted control stations, recorders or indicators shall have a nameplate indicating their function and the variable controlled or displayed. Nameplate shall be attached by one of the above methods.

F. Electronic Equipment

1. If the equipment is electronic in nature, provide solid state equipment to the greatest extent practicable. Select components of construction for their suitability and reliability. Employ adequate component derating to preclude failures because of transients and momentary overloads reasonably expected in normal operation. Where conduit connection is provided for mounting a surge/lightning suppresser directly to the instrument, the arrestor shall be so mounted.

G. Equipment Operating Conditions

1. Equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:
2. Power:
 - a. Electrical. 115 VAC +/- 10%, 60 Hz +/-1 Hz except where specifically stated otherwise on the drawings or in the specifications.
3. Field Instruments:
 - a. Atmospheric contaminants (All Areas):
 - i. Hydrogen Sulfide: 0.1 mg/l
 - ii. Chlorine: 0.01 mg/l
 - iii. Ammonia: 0.5 mg/l
 - iv. Dust: 50.0 µg/m³
 - b. Outdoor Areas:
 - i. Ambient Temperature: -20°F to +120°F
 - ii. Ambient Relative Humidity: 10% to 95%
 - iii. Weather: Rain, wind, sun and blowing sand.

4. Indoor Environmentally Uncontrolled Areas:
 - a. Ambient Temperature: 40°F to +105°F
 - b. Ambient Relative Humidity: 20% to 80%
5. Indoor Environmentally Controlled Areas:
 - a. Ambient Temperature: 55°F to +85°F
 - b. Ambient Relative Humidity: 20% to 80%
 - c. Short term excursions to temperature limits for non-environmental controlled areas.
6. Provide, as necessary, enclosures, heat tracing, heaters and sunshields, etc. to assure normal operations under these conditions.
7. Corrosive Areas: Provide instrument enclosures and hardware suitable for the corrosive location.
8. Hazardous Areas: All equipment used in areas designated as hazardous shall be designed for the Class, Group, and Division as required on the Electrical Drawings for the locations. All work shall be in strict accordance with codes and local rulings, should any work be performed contrary to said rulings, ordinances and regulations, the Supplier shall bear full responsibility for such violations and assume all costs arising there from

H. Power Supplies

1. Provide electrical instruments and control devices for operation on 120 VAC, 60 Hz current.
2. Unless otherwise indicated provide battery backed up Uninterruptable Power Supply (UPS) with AC inversion for each control panel and PLC. UPS shall be sized to run the peak tributary load for a period of not less than 30 minutes. UPS shall be mounted in the respective panel. Minimum UPS size shall be 500 watt-hour. Provide bypass switch for panels to run directly from power source or through UPS with front of panel mounted indicator light showing current models.
3. Output overvoltage and overcurrent protective devices shall be provided for DC power supplies to protect instruments from damage due to power supply failure and to power supply from damage due to external failure. Power supplies shall be provided with NEMA 1 enclosures. Power supplies shall be mounted such that dissipated heat does not adversely affect other components. Source of operating power shall be 120 VAC, 60 Hz commercial power. Units shall be mounted within the control panels. Power supply fusing shall be provided with blown fuse indicators.

I. Signal Isolators, Converters and Conditioners

1. Insure that input-output signals of all instruments and control devices (new and existing) are compatible. Analog signals between field and panels shall be Profibus unless specifically approved otherwise. Granting such approval does not relieve the Company from the compatibility requirement above. Provide signal isolators and converters as necessary to obtain the required system performance. Mount the devices behind control panels or in the field at point of application, as required for accurate signal acquisition.

J. Auxiliary Contacts by Others

1. Provide instruments and equipment to connect to auxiliary contacts provided by others for alarms, status of equipment, interlocking, and other functions as indicated and as specified herein.

K. Painting

1. Provide factory paint for instruments and equipment except where in pipelines. Provide paint as required in Division 9 for non-stainless steel structural supports, brackets, etc.

L. Electrical

1. Work shall include the power supply wiring, instrumentation wiring, interconnecting wiring and equipment grounding as indicated, specified and required and not specifically included under Division 16.
2. Wiring installations shall include cables, conductors, terminals, connectors, wire markers, conduits, conduit fittings, supports, hardware and all other required materials not specifically included in the work of other Divisions.
3. Provide the materials and complete the required installations for equipment grounding as specified in Division 16 of these Specifications and indicated on the Electrical Drawings.
4. Incidental items not specifically included in the Company Documents that can legitimately and reasonably be inferred to belong in the instrumentation work shall be provided and installed by the Company at no additional cost to the City.
5. Field Wiring. For wiring materials, refer to Division 16 and Details on the Electrical Drawings. Test signal wiring for continuity prior to termination. Provide wire number tags marked in indelible waterproof form of slip-on type heat shrink label or equal for each termination.

M. Process Connections

1. Provide instrument piping, tubing, and capillary tubing to meet the intended process service and ambient environmental condition for corrosion resistance, etc. All instrument pneumatic tubing shall be 316 SS. Slope lines according to service to promote self draining or venting back to the process. Terminate connection to process lines or vessels in a service rated block valve that will permit closing off the sense line or removal of the element without requiring shut down of the process. Include drip legs and blow-down valves for terminations of sense lines at the instruments when mounted such that condensation can accumulate. Process vessels, line penetrations, connecting fittings, and block valves shall be furnished and installed under other Divisions of these Specifications but coordinated by this Division.

N. Spares and Maintenance Materials

1. Furnish the following items as specified herein. Deliver to City Engineer, as directed, with itemized list in a letter of transmittal accompanying each shipment.
2. Materials shall be delivered in the manufacturer's original containers labeled to completely describe contents and equipment for which it is furnished.
3. One Fuse of each size and type for every five used but no less than five of each type.
4. One Relay of each type for every five used but no less than two of each type.
5. One Panel Indicating Light Bulb for every five used but no less than four of each type.
6. One PLC I/O and communication card of each type.
7. One Transient Protector for every five used but no less than four of each type.

PART 3 - EXECUTION

3.01 PRODUCT HANDLING

- A. Shipping Precautions: After completion of shop assembly, factory test, and approval, all equipment, cabinets, panels, and consoles shall be packed in protective crates and enclosed in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture. Dehumidifiers shall be placed inside the polyethylene coverings. The equipment shall then be skid-mounted for final transport. Lifting rings shall be provided for moving without removing protective covering. Boxed weight shall be shown on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.
- B. Special Instructions: Special instructions for proper field handling, storage, and installation required by the Manufacturer shall be securely attached to each piece of equipment before packaging and shipment.
- C. Tagging: Each component shall be tagged to identify its location, instrument tag number, and function in the system. A permanent stainless steel or other non-corrosive material tag firmly attached and permanently and indelibly marked with the instrument tag number, as given in the tabulation, shall be provided on each piece of equipment in the ICM system. Identification shall be prominently displayed on the outside of the package.
- D. Storage: Equipment shall not be stored outdoors. Equipment shall be stored in dry permanent shelters, including in-line equipment, and shall be adequately protected against mechanical injury. If any apparatus has been damaged, such damage shall be repaired by the Company at no additional cost to the City. If any apparatus has been subject to possible damage by water, it shall be thoroughly dried out and put through tests as directed by the City Engineer. Such tests shall be at no additional cost to the City, and if the equipment fails the tests, it shall be replaced at no additional cost to the City.
- E. Protection during Construction: Instrumentation and Controls shall at all times during construction be adequately protected against mechanical injury, water damage, corrosion, dirt, dust and foreign material. Equipment equipped with internal electrical heaters shall have them energized to keep the equipment dry. Doors to control panels and cabinets shall be kept closed at all times when work on them is not being done. Control Panels, Analyzers, sensitive electronic or computer equipment and/or controls or other materials not sealed and/or suitable for continuous outdoors storage shall not be stored out-of-doors. Such Instrumentation and Controls shall be stored in dry permanent shelters.
- F. Paint Finish: Any damage to factory applied paint finish shall be repaired using touch-up paint furnished by the instrument or equipment manufacturer.

3.02 MANUFACTURER'S SERVICES

- A. Furnish the following Manufacturer's services for the instrumentation listed above:
 - 1. Perform bench calibration
 - 2. Oversee installation
 - 3. Verify installation of installed instrument
 - 4. Certify installation and reconfirm Manufacturer's accuracy statement
 - 5. Oversee loop testing, prepare loop validation sheets, and certify loop testing

6. Oversee pre-commissioning, prepare pre-commissioning validation sheets, and certify pre-commissioning
7. Train the City's personnel

3.03 INSTALLATION

A. General:

1. All instrumentation, including instrumentation furnished under other Divisions, shall be installed per the manufacturers' instructions and Division 13.
2. Equipment Locations: The monitoring and control system configurations indicated are diagrammatic. The locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the City exercises the right to require changes in location of equipment that do not impact material quantities or cause material rework, make such changes without additional cost to the City.

B. Conduit, Cables, and Field Wiring

1. All conduit shall be provided under Division 16.
2. All 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, remote I/O, PLC I/O, and other non-specialty field wiring and cables shall be provided and installed under Division 16.
3. All ICM system specialty cables, data highway fiber optic cable and specialty cable termination devices shall be provided under Division 13 and installed under Division 16.
4. All field cables and wiring terminations and wire identification at ICM system equipment furnished under this or any other Division shall be provided under Division 16. All terminations shall be checked by the equipment supplier and the electrical contractor.

C. Instrumentation Tie-Downs: All instruments, control panels, and equipment shall be anchored by methods that comply with seismic requirements that apply to the site.

D. Existing Instrumentation: Each existing instrument to be removed and reinstalled shall be cleaned, reconditioned and recalibrated by an authorized service facility of the instrument Manufacturer. Provide certification of this Work before reinstallation of each instrument. Provide replacement for interim period as required.

E. Ancillary Devices: The Company Documents show all necessary conduit and instruments required to make a complete instrumentation system. The Company shall be responsible for providing any additional or different type connections as required by the instruments and specific installation requirements at no additional cost to the City. All such additions and all such changes, including the proposed method of installation, shall be submitted to the City Engineer for approval before commencing the Work. Such changes shall not be a basis of claims for extra work or delay.

F. Installation Criteria and Validation: All field-mounted components and assemblies shall be installed and connected according to the requirements below:

1. Installation personnel have been instructed on installation requirements of the Company Documents.
2. Technical assistance is available to installation personnel at least by telephone.
3. Installation personnel have at least one copy of the approved shop drawings and data.
4. Instrument process sensing lines shall be installed similar to conduit specified under Section 16050 - Basic Electrical Materials and Methods. Individual tubes shall run parallel and near the surfaces from which they are supported. Supports shall be used at intervals of not more than 3 feet of rigid tubing.
5. Bends shall be formed to uniform radii with the proper tool without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square-cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at all panels requiring pipe or tubing entries.
6. All differential pressure elements shall have three valve manifolds.
7. All flexible cables and capillary tubing shall be installed in flexible conduits. The lengths shall be sufficient to withdraw the element for periodic maintenance.
8. All power and signal wires shall be terminated with crimped type lugs.
9. All connectors shall be, as a minimum, water tight.
10. All wires shall be mounted clearly with an identification tag that is of a permanent and reusable nature.
11. All wire and cable shall be arranged in a neat manner and securely supported in cable groups and connected from terminal to terminal without splices unless specifically approved by the City Engineer. All wiring shall be protected from sharp edges and corners.
12. All mounting stands and bracket materials and workmanship shall comply with requirements of the Company Documents.
13. Verify the correctness of each installation, including polarity of electric power and signal connections, and making sure all process connections are free of leaks. Certify in writing that for each loop or system checked out, all discrepancies have been corrected.
14. The City will not be responsible for any additional cost of rework attributable to actions of the Company or the CSI.

3.04 CALIBRATION

- A. General: All devices provided under the instrumentation Sections shall be calibrated according to the manufacturer's recommended procedures to verify operational readiness and ability to meet the indicated functional and tolerance requirements.
- B. Calibration Points: Each instrument shall be calibrated at 0, 50, and 100% of span using test instruments to simulate inputs. The test instruments shall have accuracies traceable to National Institute of Testing Standards.
- C. Bench Calibration: Instruments that have been bench-calibrated shall be examined in the field to determine whether any of the calibrations are in need of adjustment. Such adjustments, if required, shall be made only after consultation with the City Engineer.
- D. Field Calibration: Instruments that were not bench-calibrated shall be calibrated in the field to insure proper operation in accordance with the instrument loop diagrams or specification data sheets.

- E. Analyzer Calibration: Each analyzer system shall be calibrated and tested as a workable system after installation. Testing procedures shall be directed by the manufacturers' technical representatives. All samples and sample gases shall be furnished by the manufacturers.
- F. Calibration Tags: A calibration and testing tag shall be attached to each piece of equipment or system at a location determined by the City Engineer. Have the Instrumentation Supplier sign the tag when calibration is complete. The City Engineer will sign the tag when the calibration and testing has been accepted.

3.05 LOOP TESTING

- A. General: Individual instrument loop diagrams per ISA Standard S5.4 - Instrument Loop Diagrams, expanded format, shall be submitted to the City Engineer for review before the loop tests. The Company shall notify the City Engineer of scheduled tests a minimum of 30 days before the estimated completion date of installation and wiring of the ICM. After the City Engineer's review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop check shall be witnessed by the City Engineer.
- B. Control Valve Tests: All control valves, cylinders, drives and connecting linkages shall be stroked from the operator interface units as well as local control devices and adjusted to verify proper control action, hand switch action, limit switch settings, torque settings, remote control actions, and remote feedback of valve status and position. Control valve actions and positioner settings shall be checked with the valves in place to insure that no changes have occurred since the bench calibration.
- C. Interlocks: All hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers and packaged equipment controls shall be checked to the maximum extent possible.
- D. Instrument and Instrument Component Validation: Each instrument shall be field tested, inspected, and adjusted to its indicated performance requirement in accordance its Manufacturer's specifications and instructions. Any instrument that fails to meet any Company requirement, or, in the absence of a Company requirement, any published manufacturer performance specification for functional and operational parameters, shall be repaired or replaced, at the discretion of the City Engineer at no additional cost to the City.
- E. Loop Validation: Controllers and electronic function modules shall be field tested and exercised to demonstrate correct operation. All control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the SCADA and PLC. Actual signals shall be used wherever available. Following any necessary corrections, the loops shall be retested. Specified accuracy tolerances for each analog network are defined as the root-mean-square-summation of individual component accuracy requirements. Individual component accuracy requirements shall be as indicated by Company requirements or by published manufacturer accuracy specifications, whenever Company accuracy requirements are not indicated. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network. For networks that incorporate analog elements, simulated sensor inputs corresponding to 20, 40, 60, 80 and 100% of span shall be applied, and the resulting element outputs monitored to verify compliance to calculated root-mean-square-summation accuracy tolerance requirements. Continuously variable analog inputs shall be applied to verify the proper operation and setting of discrete devices. Provisional settings

discrete devices. Provisional settings shall be made on controllers and alarms during analog loop tests. All analog loop test data shall be recorded on test that include calculated root-mean-square-summation system accuracy tolerance requirements for each output.

- F. Loop Validation Sheets: Prepare loop confirmation sheets for each loop covering each active instrumentation and control device except simple hand switches and lights. Loop confirmation sheets shall form the basis for operational tests and documentation. Each loop confirmation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete loop by the CSI:
 - 1. Project name
 - 2. Loop number
 - 3. Tag number, description, manufacturer and model number for each element
 - 4. Installation bulletin number
 - 5. Specification sheet number
 - 6. Loop description number
 - 7. Adjustment check
 - 8. Space for comments
 - 9. Space for loop sign-off by Instrumentation Supplier and date
 - 10. Space for City Engineer witness signature and date
- G. Loop Certifications: When installation tests have been successfully completed for all individual instruments and all separate analog control networks, a certified copy of all test forms signed by the City Engineer as a witness, with test data entered, shall be submitted to the City Engineer together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.

3.06 PRE-COMMISSIONING

- A. General: Pre-commissioning shall start after acceptance of all wire test, calibration tests and loop tests, and all inspections have demonstrated that the instrumentation and control system complies with all Company requirements. Pre-commissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
- B. Pre-commissioning Procedures and Documentation: All pre-commissioning and test activities shall follow detailed test procedures and check lists accepted by the City Engineer as submitted for approval by the CSI. All test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the City Engineer, that include calculated tolerance limits for each step. Completion of all system pre-commissioning and test activities shall be documented by a certified report, including all test forms with test data entered, delivered to the City Engineer with a clear and unequivocal statement that all system pre-commissioning and test requirements have been satisfied.
- C. Operational Validation: Where feasible, system pre-commissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is

is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation. The transient stability of final control elements operating under the control of field mounted, and software based automatic analog controllers shall be verified by applying control signal disturbances, monitoring the amplitude and decay rate of control parameter oscillations (if any) and making necessary controller adjustments as required to eliminate excessive oscillatory amplitudes and decay rates.

- D. Loop Tuning: All electronic control stations incorporating proportional, integral or differential control circuits shall be optimally tuned, experimentally, by applying control signal disturbances and adjusting the gain, reset, or rate settings as required to achieve a proper response. Measured final control element variable position/speed set point settings shall be compared to measured final control element position/speed values at 20, 40, 60, 80 and 100% of span and the results checked against indicated accuracy tolerances.
- E. Pre-commissioning Validation Sheets: Pre-commissioning shall be documented on one of two types of test forms as follows:
 - 1. For functions that can be demonstrated on a loop-by-loop basis, the form shall include:
 - a. Project name
 - b. Loop number
 - c. Loop description
 - d. Tag number, description, manufacturer and data sheet number for each component.
 - e. Space for sign-off and date by both the CSI and the City Engineer.
 - 2. For functions that cannot be demonstrated on a loop-by-loop basis, the test form shall be a listing of the specific tests to be conducted. With each test description the following information shall be included:
 - a. Specification page and paragraph of function demonstrated
 - b. Description of function
 - c. Space for sign-off and date by both the CSI and the City Engineer.
- F. Pre-commissioning Certification: Submit an ICM system pre-commissioning completion report that shall state that all Company requirements have been met and shall include a listing of all instrumentation and control system maintenance and repair activities conducted during the pre-commissioning testing. Acceptance of the instrumentation and control system pre-commissioning testing must be provided in writing by the City Engineer before the performance testing may begin. Final acceptance of the control system shall be based upon plant completion as stated in the Service Contract.

3.07 ONSITE SUPERVISION

- A. Furnish the services of an on-site service engineer to supervise and coordinate installation, adjustment, testing, and start-up of the ICM system. The City Engineer will be present during the total period required to effect a complete operating system. A qualified team of the Instrumentation Subcontractor personnel shall be on site as required to check all equipment, perform the tests

perform the tests indicated in this Section, and furnish startup services.

3.08 PERFORMANCE TEST

- A. The entire ICM system shall operate for 30 days without failure.
- B. Furnish all necessary support staff as required to maintain the system and to satisfy the repair or replacement requirements.
- C. If any component fails during the performance test, it shall be repaired or replaced within 4 hours and the ICM system shall be restarted. If the system is not repaired and running within four (4) hours the system shall be restarted and operate for and additional 30 days without failure.

3.09 TRAINING – NOT USED

3.10 ACCEPTANCE

- A. For the purpose of this Section, the following conditions shall be fulfilled before the Work is considered substantially complete:
 - 1. All submittals have been completed and approved.
 - 2. The ICM system has been calibrated, loop tested and pre-commissioned.
 - 3. All required spare parts and expendable supplies and test equipment have been delivered to the City.
 - 4. The performance test has been successfully completed.
 - 5. All punch-list items have been corrected.
 - 6. All record drawings in both hard copy and electronic format have been submitted.
 - 7. Revisions to the operations and maintenance manuals information that may have resulted from the field tests have been made and reviewed.
 - 8. All debris associated with installation of instrumentation has been removed.
 - 9. All probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

3.11 WARRANTY

- A. Supplier shall warrant design, materials, and workmanship for customary period applicable for the equipment involved, but in no case for less than twelve months from date of acceptance.
- B. During warranty period, if mechanical defects occur, or equipment fails to perform in accordance with specified performance requirements under conditions of normal use within the design limitations of the equipment, supplier shall, upon request of the company, repair or replace equipment or parts as required and shall place equipment in proper working condition, assuming all expenses involved.
- C. A written prepaid maintenance contract executed by the CSI shall be provided to the City for on-site warranty and travel maintenance services. This maintenance contract shall include all travel and living expenses, labor, parts, and emergency calls providing on-site response within 4 hours, to provide complete system maintenance for a period of one year after the date of final acceptance of the system.

- D. The maintenance contract shall include a minimum of 4 (quarterly) preventive maintenance visits by a qualified serviceman of the Supplier who is familiar with the type of equipment and software provided for this project. Each preventive maintenance visit shall include routine adjustment, calibration, cleaning, and lubrication of system equipment and written verification of calibration and correct software operation.
- E. An annual fee shall be quoted 90 days before completion of the first year maintenance contract for annual maintenance subsequent to the first year of operation. Standard per diem rates for providing breakdown service shall be set forth in the contract. Such rates shall be fair and reasonable and reflect the lowest rates offered to most favored customers. The fee quoted shall be firm for a minimum of 90 days from day of issue.

END OF SECTION

SECTION 13321

INSTRUMENTATION

PART 1 - GENERAL

1.01 SUMMARY:

The Company shall furnish, install and place into service operating process instrumentation, control systems and panels including accessories, related to this facility, all as shown on plans and specified herein. The Control System as specified shall be provided, installed, configured, programmed, tested and commissioned by a Single Systems Integrator. The Design-Build Work Includes: Engineering, furnishing, installing, calibrating, adjusting, testing, documenting and starting up for a complete Instrumentation and Control System.

Major parts are:

1. Instrumentation including primary elements, transmitters, and control devices.
2. Control Panels and DIO panels.
3. Programmable Logic Controllers.
4. Workstations and Human Machine Interface (HMI) software.
5. Programming and Testing.

B. Single Systems Integrator Design-Build Work Scope

1. For I&C equipment and ancillaries provide the following:
 - a. Completing detail design.
 - b. Required Submittals.
 - c. Equipment and ancillaries.
 - d. Instructions, details, and recommendations to, and coordination with, Company for proper installation.
 - e. Verify readiness for operation.
 - f. Verify the correctness of final power and signal connections.
 - g. Adjusting and calibrating.
 - h. Starting up.
 - i. Testing and coordination of testing.
 - j. Training.
2. Verify following work not provided by the Single Systems Integrator is provided:
 - a. Correct type, size, and number of signal wires with their raceways.
 - b. Correct electrical power circuits and raceways.
 - c. Correct size, type, and number of I&C related pipes, valves, fittings, and tubes.
 - d. Correct size, type, materials, and connection of process mechanical piping for in-line primary elements.
3. For equipment not provided by the Single Systems Integrator, but directly connected to equipment required by Systems Integrator:

- a. Obtain from Company, manufacturer's information on installation, interface, function, and adjustment.
 - b. Coordinate with Company to allow required interface and operation with I&C System.
 - c. For operation and control, verify that installations, interfacing signal terminations, and adjustments have been completed with manufacturer's recommendations.
 - d. Test to demonstrate required interface and operation with I&C System.
 - e. Examples of items in this category, but not limited to the following:
 - i. Valve operators, position switches, and controls.
 - ii. Motor control centers.
 - iii. Variable frequency drive systems.
 - f. Examples of items not in this category:
 - i. Internal portions of equipment provided under Division 16, Electrical, that are not directly connected to equipment under I&C System.
 - ii. Internal portions of I&C Systems provided as part of package systems and that are not directly connected to equipment provided under I&C System.
4. Wiring external to equipment provided by Single Systems Integrator:
- a. Special control and communications cable: Provided by Single Systems Integrator.

1.02 SINGLE SYSTEMS INTEGRATOR:

The Company shall assign to the Single Systems Integrator full responsibility for the functional operation of all new instrumentation systems. The Company shall have said Systems Integrator perform all engineering necessary in order to select, to furnish, to program to supervise installation, connection, to calibrate, to place into operation of all sensors, instruments, alarm equipment, control panels, accessories, and all other equipment as specified herein. The Single Systems Integrator shall have a maintenance office within a 200 mile radius of the project.

The Single Systems Integrator shall demonstrate his ability to successfully complete projects of similar sizes and nature. Provide references (including phone number and contact name) for at least three projects successfully completed in which the following tasks were performed: system engineering, documentation including panel assembly, schematics and wiring diagram, programming, field testing, calibration and start-up, operator instruction and maintenance training.

The foregoing shall enable the Company and the City to be assured that the full responsibility for the requirements of this Section shall reside in an organization which is qualified and experienced in the water management field and its process technology on a functional systems basis.

The Single Systems Integrator shall have a U.L. approved shop and shall build all panels according to U.L. 508.

1.03 INSTALLATION DESIGN-BUILD WORK:

Nothing in this part of the Specifications shall be construed as requiring the Company to utilize personnel supplied by his assigned instrument manufacturer's organization, or any division thereof, to accomplish the physical installation of any elements, instruments, accessories or assemblies specified herein. However, the Company shall employ installers who are skilled and experienced in the installation and connection of all elements, instruments, accessories and assemblies; portions of their work shall be supervised or checked as specified in Part 3, herein.

1.04 PREPARATION OF SUBMITTAL OF DRAWINGS AND DATA:

- A. It is incumbent upon the Company to coordinate the Design-Build Work specified in these Sections so that a complete I&C system for the facility shall be provided and shall be supported by accurate Shop and record Drawings. As a part of the responsibility as assigned by the Company, the Single Systems Integrator shall prepare and submit through the Company, complete organized Shop Drawings, as specified in Part 2.02, herein. Additional submittal requirements are detailed in Appendix 5 of the Service Contract. Loop drawings depicting the Interface between instruments, motor starters, packaged equipment, etc. shall be included in his Shop Drawing submittal. The system integrator must prepare an I/O list and provide it as a submittal. The submitted I/O list must include a minimum 50% spare I/O of each type and include the I/O addresses and I/O card layout. The contractor shall coordinate the P&IDs and I/O list with the specific equipment manufacturer provide a list of differences and submit the manufacturer specific P&ID and I/O list.
- B. During the period of preparation of this submittal, the Company shall authorize direct, informal liaison between his Single Systems Integrator and the City for exchange of technical information. As a result of this liaison, certain minor refinements and revisions in the systems as specified may be authorized informally by the City, but these shall not alter the scope of Design-Build Work or cause increase or decrease in the Service Contract Price. During this informal exchange, no oral statement by the City shall be construed to give formal approval of any component or method, nor shall any statement be construed to give formal exception to, or variation from these Specifications. The submittal drawings and technical information shall be signed and seal by a registered and licensed Florida professional engineer.

1.05 ADDITIONAL TECHNICAL SERVICES:

1. At no separate additional cost to the City, the Company shall provide the following services of qualified technical representatives of the Single Systems Integrator (See Part 3, herein).
2. To supervise installation and connection of all instruments, elements, and components of every system, including connection of instrument signals to primary measurement elements and to final control elements such as pumps, valves, and chemical feeders;
3. To make all necessary adjustments, calibrations and tests; and

1.06 WARRANTY:

The Company shall warranty all equipment and installation, as specified herein, for a period of one (1) year following the date of completion of the Design-Build Work. To fulfill this obligation, the Company shall utilize technical service personnel designated by the Single Systems Integrator to which the Company originally assigned project responsibility for instrumentation. Services shall be performed within two (2) calendar days after notification by the City.

1.07 ADDITIONAL PROVISIONS:

The applicable provisions of the following Sections under Electrical work shall apply to Design-Build Work and equipment specified herein, the same as if stated in full, herein:

1. Codes and Standards.
2. Equipment, Materials and Workmanship.
3. Testing.
4. Grounding.
5. Equipment Anchoring.

6. Conductor and Equipment Identification.
7. Terminal Cabinets and Control Compartments.
8. Process Control Devices.

1.08 NEWEST MODEL COMPONENTS:

All meters, instruments, and other components shall be the most recent field proven models marketed by their manufacturers at the time of submittal of Shop Drawings unless otherwise specified to match existing equipment. All technical data publications included with submittals shall be the most recent issue.

PART 2 - PRODUCTS

2.01 INSTRUMENTATION CRITERIA:

A. Designation of Components

In these Specifications and on the Drawings, all systems, meters, instruments, and other elements are represented schematically, and are designated by numbers, as derived from criteria in Instrument Society of American Standard ANSI/ISA S5.1-1973. The nomenclature and numbers designated herein and on the Drawings shall be employed exclusively throughout Shop Drawings, data sheets, and similar materials. Any other symbols, designations, and nomenclature unique to the manufacturer's standard methods shall not replace these prescribed above, used, herein and on the Drawings.

B. Signal Characteristics

Signals shall be electrical, as indicated herein, and shall vary in direct linear proportion to the measured variable, except as noted. Electrical signals outside control panel(s) shall be 4 to 20 milliamperes DC, except as noted. Signals within enclosures may be 1-5 volts DC.

C. Matching Style, Appearance and Type

1. All instruments to be panel mounted at the control panels shall have matching style and general appearance.
2. Instruments performing similar functions shall be of the same type, model, or class, and shall be of one (1) manufacturer.

D. Accuracy and Repeatability

The overall accuracy of each instrumentation system or loop shall be as prescribed in the Specifications for that system or loop. Each system's accuracy shall be determined as a probable maximum error; this shall be the square-root of the sum of the squares of certified "accuracy s" of certain designated components in each system, expressed as a percentage of the actual span or value of the measured variable. Each individual electronic instrument shall have a minimum accuracy of ± 0.7 percent of full scale and a minimum repeatability of ± 0.4 percent of full scale unless otherwise specified. Instruments which do not conform to or improve upon these criteria are not acceptable.

E. Signal Isolators, Converters and Power Supplies

Signal isolators shall be furnished and installed in each measurement and control loop, wherever required, to insure adjacent component impedance match or where feedback paths may be generated. Signal converters shall be included where required to resolve any signal level incompatibilities. Signal power supplies shall be included, as required by the manufacturer's instrument load characteristics, to insure sufficient power to each loop component.

F. Alternative Equipment or Methods

1. Equipment or methods requiring redesign of any project details are not acceptable without prior approval of the City. Any changes inherent to a proposal alternative shall be at no additional cost to the City.
2. The required approval shall be obtained in writing by the I&C Subcontractor through the Company prior to submittal of Shop Drawings and data. Any proposal for approval of alternative equipment or methods shall include evidence of improved performance, operational advantage and maintenance enhancement over the equipment or method specified, or shall include evidence that a specified component is not available. Otherwise, alternative equipment (other than direct, equivalent substitutions) and alternative methods shall not be proposed.

2.02 DETAILED SYSTEMS DRAWINGS AND DATA:

A. Content

The Company shall submit detailed Shop Drawings and data prepared and organized by the Single Systems Integrator designated at the time of bidding. The quantity of submittal sets required shall be six (6). These Drawings and data shall be submitted as a complete bound package at one time within 80 calendar days after date of Construction Date and shall include:

1. Drawings showing definite diagrams for every instrumentation loop system. These diagrams shall show and identify each component of each loop or system using legend and symbols from ISA Standard S5.4, each having the format of ISA Standard S5.1 as used on the Project Drawing. (Each system or loop diagram shall be drawn on a separate Drawing sheet).
2. The City shall supply preliminary data sheets for field instrumentation. All data sheet information shall be verified for each component, together with a technical product brochure or bulletin. The data sheets shall show:
 - a. Component function description used herein and on the Drawings;
 - b. Manufacturer's model number or other product designation;
 - c. Project tag number used herein and on the Drawings;
 - d. Project system loop of which the component is a part;
 - e. Project location or assembly at which the component is to be installed;
 - f. Input and output characteristics;
 - g. Scale range and units (if any) and multiplier (if any);
 - h. Requirements for electric supply (if any);
 - i. Requirements for air supply (if any);
 - j. Materials of component parts to be in contact with, or otherwise exposed to, process media;
 - k. Special requirements or features

3. A complete index shall appear in the front of each bound submittal volume. A separate technical brochure or bulletin shall be included with each instrument data sheet. The data sheets shall be indexed in the submittal by systems or loops, as a separate group for each system or loop. Each brochure or bulletin shall include a list of tag numbers for which it applies. System groups shall be separated by labeled tags.
4. Drawings showing both schematic and wiring diagrams for control circuits. Complete details on the circuit interrelationship of all devices within and outside each control panel shall be submitted using schematic control diagrams. Subsequent to return of this first submittal by the City, piping and wiring diagrams shall be prepared and submitted for review by the City; the diagrams shall consist of component Layout Drawings to scale, showing numbered terminals on components together with the unique number of the wire to be connected to each terminal. Piping and wiring diagrams shall show terminal assignments from all primary measurement devices, such as flow meters, and to all final control devices, such as samplers, pumps, valves, and chemical feeders. The Company shall furnish all necessary equipment supplier's Shop Drawings to facilitate inclusion of this information by the Single Systems Integrator.
5. Schematic and wiring diagram criteria shall be followed as established in NEMA Standards Publication ANSI/NEMA ICS-1-1978, "Industrial Control and Systems."
6. Assembly and construction Drawings for each control panel and for other special enclosed assemblies for field installation. These Drawings shall include dimensions, identification of all components, surface preparation and finish data, nameplates, and the like. These Drawings also shall include enough other details, including prototype photographs, to define exactly the style and overall appearance of the assembly; a finish treatment sample shall be included.
7. Installation, mounting and anchoring details for all components and assemblies to be field-mounted, including conduit connection or entry details.
8. Complete and detailed bills of materials. A master Bill of Materials listing all field mounted devices, control panels and other equipment that shall be shipped to the job site. A Bill of Materials for each control panel listing all devices within the panel.
9. Modifications to existing equipment. A complete description of all proposed modifications to existing instrumentation equipment, control panels, control devices, cabinets, etc., shall be submitted with the Shop Drawings complete with detailed Drawings of the proposed modifications.

B. Organization and Binding

1. The organization of initial Shop Drawing submittal required above shall be compatible to eventual inclusion with the Technical Manuals submittal and shall include final alterations reflecting "as built" conditions.
2. Accordingly, the initial multiple copy Shop Drawing submittal shall be separately bound in 3-ring binders of the type specified under Part 2.03, herein, for the Technical Manuals.

2.03 TECHNICAL MANUALS:

- A. Five (5) final sets of technical manuals shall be supplied for the City, and one (1) final set shall be supplied for the City, as a condition of acceptance of the project. Each set shall consist of one (1) or more volumes, each of which shall be bound in a standard size, three-ring, loose-leaf, vinyl plastic hard cover binder suitable for bookshelf storage. Binder ring size shall not exceed 3.0 inches.

- B. Initially, two (2) sets of these manuals shall be submitted to the City for favorable review after return of favorably reviewed Shop Drawings and data required under Part 3, herein. Following the City's review, one (1) set shall be returned to the Company with comments. The sets shall be revised and/or amended as required and the requisite final sets shall be submitted to the City fifteen (15) days prior to start-up of systems. The City shall distribute the copies.
- C. In addition to updated Shop Drawing information to reflect actual existing conditions, each set of technical manuals shall include installation, connection, operating, trouble-shooting, maintenance, and overhaul instructions in complete detail. This shall provide the City with comprehensive information on all systems and components to enable operation, service, maintenance, and repair. Exploded or other detailed views of all instruments, assemblies, and accessory components shall be included together with complete parts lists and ordering instructions.

2.04 SPARE PARTS:

- A. The Company shall include, as part of the bid package, a list of recommended spare parts covering items required under this Specification except PLCs. The total price of these spare parts shall not be less than \$10,000.00 and this sum shall be a part of the Company's total bid price. The Single Systems Integrator in fact shall be responsible for delivery of the spare parts, as directed by the City after plant start-up. Prior to delivery of the spare parts, the City shall have the option of adding or exchanging any originally enumerated component based on current list prices for each item. The Company shall also submit a list of recommended equipment for maintaining and calibrating equipment furnished under this Specification.
- B. The Company shall include, as part of the bid package, a list of recommended spare parts covering items required. The Company shall provide a minimum of 1 of each CPU, rack, power supply and I/O card, and an additional card for every five (5) used. Provide 25% Spares I/O and a minimum of 1 module, card, and device for each PLC, DIO, communication module, bridge, and terminators. Include a termination kit for each type of cable.
- C. The total price of these spare parts shall be a part of the Company's total bid price. The Single Systems Integrator in fact shall be responsible for delivery of the spare parts, as directed by the City either during or after plant start-up. Prior to delivery of the spare parts, the City shall have the option of adding or exchanging any originally enumerated component based on current list prices for each item.

2.05 CONTROL PANELS:

A. General

1. Control Panels.

- a. New control panels shall be furnished and installed under this Service Contract. They shall house the instrumentation, control devices, indicating lights, PLC, RTU, alarm chassis, displays, all necessary accessories, wiring and terminal blocks as necessary and as shown on the Drawings and as described herein.
- b. Control panel doors shall be equipped with a door latch kit or a fast operating clamp assembly as applicable.
- c. Control Panels shall have a door mount NEMA style control power disconnect switch.
- d. 120 volt AC control voltage in a control panel shall be supplied with a line noise suppressing transformer. Each control panel shall be properly grounded and as such be provided with a ground terminal block. Control panels shall be properly sized for

installation through new and existing entry ways and custom, fit for locations as shown on the drawings..

B. Construction

1. Building: Control panels inside a building (not in a control room) shall be NEMA 12, 304 stainless steel 14 gauge construction. Control panels in corrosive areas shall be construed to be outdoors.
2. Outdoor: All outdoor control panels shall be NEMA 12 with drip shield kit, 3 point latch mechanism and 316 stainless steel 14 gauge construction.
3. Cooling: Control panels shall have sufficient cooling and/or ventilation not to exceed the maximum operating temperature of any of the internal components. Ambient temperature limits shall be 90 degrees F for indoor and 100 degrees F for outdoor control panels. Outdoor control panels with electronic equipment shall be furnished with sun shields around and on top of the control panels. Panels equipped with PLCs shall have 2 louvers on bottom and a thermostat controlled exhaust fan on top. Outdoor panels shall be equipped with insect screen.

C. Signal and Control Circuit Wiring

1. Wire Type and Sizes: Conductors shall be flexible stranded copper wire; these shall be U.L. listed Type THHN and shall be rated 600 volts. Wire for control signal circuits and alarm input circuits shall be 14 AWG. All instrumentation cables shall be shielded No. 16 AWG with a copper drain wire unless specified otherwise.
2. All special instrumentation cable such as between sensor and transmitter shall be supplied by the Single Systems Integrator.
3. Wire Insulation Colors: Conductors supplying 120 volt AC power on the line side of a disconnecting switch shall have a black insulation for the ungrounded conductor. Grounded circuit conductors shall have white insulation. Insulation for ungrounded 120 volt AC control circuit conductors shall be red. All wires energized by a voltage source external to the control board(s) shall have yellow insulation. Insulation for all DC conductors shall be blue.
4. Wiring Installation: All wires shall be run in plastic wireways except (1) field wiring, (2) wiring run between mating blocks in adjacent sections, (3) wiring run from components on a swing-out panel to components on a part of the fixed structure, and (4) wiring run to panel mounted components. Wiring run from components on a swing-out panels to other components on a fixed panel shall be made up in tied bundles. These shall be tied with nylon wire ties, and shall be secured to panels at both sides of the "hinge loop" so that conductors are not strained at terminals.
5. Wiring run to control devices on the front panels shall be tied together at short intervals with nylon wire ties and secured to the inside face of the panel using adhesive mounts.
6. Wiring to rear terminals on panel mount instruments shall be run in plastic wireways secured to horizontal brackets run above or below the instruments in about the same plane as the rear of the instruments.
7. Shields-of shielded instrument cable shall only be grounded on one side of each cable run. The side to be grounded shall be at the panel.
8. Care shall be exercised to properly insulate the ungrounded side, to prevent ground loops from occurring.
9. Conformance to the above wiring installation requirements shall be reflected by details shown on the Shop Drawings for the City Engineer's review.

10. Wire Marking: Each signal, control, alarm, and indicating circuit conductor connected to a given electrical point shall be designated by a single unique number which shall be shown on all Shop Drawings. These numbers shall be marked on all conductors at every terminal using permanently marked heat-shrink plastic. Instrument signal circuit conductors shall be tagged with unique multiple digit numbers. Black and white wires from the circuit breaker panelboard shall be tagged including the one (1) or two (2) digit number of the branch circuit breaker.
11. Terminal Blocks: Terminal blocks shall be molded plastic with barriers and box lug terminals, and shall be rated 15 amperes at 600 volts. White marking strips, fastened securely to the molded sections, shall be provided and wire numbers or circuit identifications shall be marked thereon with permanent marking fluid. Terminal blocks shall be Square D, Allen Bradley, General or pre-approved equal.

D. Painting

Control panels shall be thoroughly cleaned and sandblasted per SSPC-SP-6 (Commercial Blast) after which surfaces shall receive a prime coat (Amercoat 185, Koppers 622HB, or equal) 3-mils dry, followed by two (2) or more finish coats (Amercoat 5401, Koppers 501, or equal) 3-mils dry, for a total thickness of the complete system of 6 mils. The finished color of the outside surfaces shall be selected by the City. The inside surfaces shall have a white finish coat.

2.06 ACCESSORIES:

- A. General purpose relays in the control panels shall be plug in type with contacts rated 10 amperes at 120 volts AC. The quantity and type of contacts shall be as shown on the Drawings. Each relay shall be enclosed in a clear plastic heat and shock resistant dust cover. Sockets for relays shall have screw type terminals. Relays shall be Potter and Brumfield Type KRP or KUP, Square-D Type K, or pre-approved equal.
- B. Time delay relays shall be solid state on-delay or off delay type with contacts rated 10 amperes at 120VAC. Units shall include adjustable dial with graduated scale or digital switch setting covering the time range in each case. Time delay relays shall be Omron series H3, SSAC type TDM or pre-approved equal.
- C. Additional slave relays shall be installed when the number or type of contacts shown exceed the contact capacity of the specified relays and timers.
- D. Switches and indicating lights shall be round 30.5mm configuration, heavy duty and corrosion resistant. Legend plate shall be standard size square style laminate with white field and black markings as shown.
- E. Indicating lights shall have 6VAC lamps and integral transformer for operation from 120VAC, unless otherwise noted. Lens color shall be as noted. All indicating lights shall be push-to-test type. Pushbuttons shall include full guard with flush button and selector switches shall include a black non-illuminated knob on switch, unless otherwise noted. Contact arrangement and configuration shall be as shown. Devices shall be Square D class 9001 type SK, Allen Bradley Bulletin 800 or equal.
- F. Circuit breakers shall be single pole, 120 volt, 15 ampere rating or as required to protect wires and equipment and mounted inside the panels as shown.

- G. Nameplates shall be supplied for identification of all field mounted elements, including flow meters and their transmitters. These nameplates shall identify the instrument, or meter, descriptively, as to function and system. These nameplates shall be fabricated from black-face, white-center, laminated engraving plastic.
- H. A nameplate shall be provided for each signal transducer, signal converter, signal isolator, each electronic trip, and the like, mounted inside the control panels. These shall be descriptive, to define the function and system of such element. Adhesives shall be acceptable for attaching nameplates. Painted surfaces must be prepared to allow permanent bonding of adhesives. Nameplates shall be provided for instruments, function titles for each group of instruments and other components mounted on the front of the control panels as shown. These nameplates and/or individual letters shall be fabricated from VI-LAM, Catalog No. 200, manufactured by N/P Company, or equivalent by Formica, or equal. Colors, lettering, style and sizes shall be as shown or as selected by the City.

2.07 PRESSURE AND PRESSURE SENSING LEVEL TRANSMITTERS - ELECTRONIC

- A. General. Signal and power transmission shall be provided by a single, shielded, twisted pair of wires.

Operating ambient temperature limits shall be at least -40 to +85 degrees C. Range shall be as indicated on the Schedule and span shall be field adjustable over at least a 5 to 1 range. Span elevation and suppression shall be provided. Reference accuracy shall be ± 0.075 percent of span or better. Integral adjustable hydraulic or electronic damping shall be provided. An indicating 4-digit LCD output meter shall be provided (scale as required).

- B. Construction. The transmitter enclosure shall be NEMA 4X rated except where explosion-proof (XP) is specified. Process fluid shall be isolated from the sensing elements by titanium diaphragms. The fill fluid shall be silicone. The Systems Integrator shall verify suitability of the instrument for that particular service. Low-pressure process connection shall be 1/2-inch NPT. For calibrated spans of less than 8.0 PSIG a differential pressure type transmitter shall be utilized. Each transmitter shall be provided with a stainless steel, three-valve manifold and a mounting bracket. Manifolds shall have test ports on the side.
- C. Manufacturers. The transmitter shall be manufactured by Endress and Hauser or pre-approved equal.

2.02 ROTAMETERS

- A. Rotameters. General Purpose.

- 1. General. Rotameters shall include 316 stainless steel housing or frame and a calibrated borosilicate glass metering tube with float. The float shall be of a material and shape suitable for the process fluid. The tube shall be readily field removable for cleaning. Other wetted parts shall be 316 stainless steel, except O-rings shall be Viton unless otherwise recommended by the manufacturer for the process fluid specified. Systems Integrator shall verify suitability for the process prior to submittal. End fittings shall be chosen to suit the installation requirements in the field. Coordinate the installation with the Company. The metering scale shall be a nominal 250-mm in length with graduations in units specified in the Schedule. Meters shall have a minimum rangeability of 10:1. Accuracy shall be ± 2 percent of full scale for flow rates in the upper 90 percent of the maximum flow range specified in the Schedule.

2. Manufacturer. Rotameters shall be manufactured by Fischer & Porter, Brooks, or approved equal.

2.03 PRESSURE AND VACUUM GAUGES

- A. General. Pressure and vacuum gauges shall, unless otherwise specified, conform to the following. Gauges shall be of the stem-mounting type unless panel-mounted type is shown on the Schedule.
- B. Construction. Gauges shall be of the bourdon tube or bellows type with 270 degrees clockwise pointer travel. Dials shall be white with black numerals. Dial size shall be 4-1/2 inches. Panel-mounted gauges shall have round bezels for flush mounting and rear connection; others shall have a stem-mounting bottom connection. Connections for gauges shall be male 1/2 NPT with square wrench flats. Wetted parts shall be corrosion-resistant to the process fluid shown in the Schedule and unless specified in the Schedule shall be the manufacturer's best quality standard. Suction gauges mounted on pumps shall be compound type and equipped with an optional pulsation snubber. When specified in the Schedule, the case shall be filled with silicone oil. Cases shall be black phenolic or stainless steel as required by mounting location. Accuracy shall be ± 0.5 percent of span.
- C. Chemical Seal. When specified in the Schedule or shown in the drawings, the gauge, with locking device option, shall be furnished with a diaphragm seal or be installed as an integral part of a tubular seal specified elsewhere. The diaphragm seal shall have a 316 stainless steel. (Minimum) top and bottom housing and a 316 stainless steel diaphragm welded to the top housing. When the process fluid or pressure is not compatible with 316 stainless steel, the SI shall provide a titanium diaphragm seal manufactured to be compatible with the process fluid. The process connection shall be a 3/4-inch-threaded connection with a flushing connection. The fill fluid shall be silicone.
- D. Manufacturers. The gauges shall be as manufactured by Ashcroft, U.S. Gage, or equal.

2.04 POWER SUPPLIES

- A. General. The regulated (linear controlled) power supplies for the instrument loops shall be designed and arranged so that the loss of one supply does not affect another loop. The output shall be provided with a protective circuit to include damping diode and varistor.
- B. Construction. Power supplies shall be suitable for an input voltage variation of 10 percent and the primary, secondary and the output shall be fused or short-circuit protected. Output voltage regulation shall be within 1% as required by the instrumentation equipment supplied. Multi-loop or multi-system power supplies will be acceptable if backup power supply units are provided which will automatically assume the load upon primary failure. Multi-system power supplies shall be designed so that either the primary or backup may be removed from service without disrupting the instrument system operation. Power distribution to loops from multi-system power supplies shall be individually fused so that a fault in one instrument loop is isolated from the others. Fuses shall be clearly labeled and shall be supplied with a blown fuse indicator. Failure of either power supply shall be annunciated at the control panel and at the SCADA terminal. Power supplies shall be DIN rail-mounted with visual indicator for faults and an LED status indicator in the secondary circuit. Wiring connections shall be to screw terminals.
- C. Manufacturer. The power supplies shall be the Compact Power Supply Unit, CM 90-PS-120 AC/24 DC/2, as manufactured by Phoenix Contact or approved equal.

2.05 PRESSURE SWITCHES

- A. General. Pressure switches shall sense absolute or gauge pressure and incorporate bourdon tubes, diaphragms, or bellows as the sensing and actuating element. On-site calibration of pressure switches is required.
- B. Construction. The actuating element shall be 316 stainless steel. The actuating point shall be readily field adjustable in the range specified, and shall be of the narrow differential (dead band) type. Switches shall be DPDT, rated at 10 amperes minimum at 120 VAC. Enclosures shall be NEMA 4 unless specified explosion-proof (XP) in the schedule. Process connection shall be 1/4-inch NPT. When specified in the schedule, switches shall have an external manual reset.
- C. Chemical Seal. When specified in the Schedule, the pressure switch shall be furnished with a diaphragm seal or be installed as an integral part of a tubular seal specified elsewhere. The diaphragm seal shall have a 316 S.S. top and bottom housing and a 316 S.S. diaphragm welded to the top housing. When the process fluid or pressure is not compatible with 316 stainless steel, the SI shall provide a titanium diaphragm seal manufactured to be compatible with the process fluid. The process connection shall be a 3/4-inch-threaded connection with a flushing connection. The fill fluid shall be silicone. An instrument-locking device shall be provided to prevent inadvertent disassembly of the unit.
- D. Manufacturers. The pressure switches shall be as manufactured by Mercoid, United Electric, ASCO, Neo-Dyne or equal. The diaphragm seals shall be as manufactured by Ashcroft, Mansfield and Green, FIT or equal.

2.06 SOLENOID VALVES

- A. Solenoid valves shall be provided as shown on the drawings. Solenoid valves shall be packless construction 2, 3 or 4-way, as required, and shall be correctly sized for the application. Valves shall operate as described in Section 15100. Solenoid valves shall include manual operators and open/close position switches. Valve bodies shall be forged brass unless otherwise recommended by the manufacturer for a particular application. The solenoids shall be rated for continuous operation of 110 percent of rated voltage. They shall be powered by 120 VAC, 60 Hertz. Coils shall be rated for 0-180 degrees F ambient operation and housed in NEMA 4 cases, except where explosion-proof (XP) is required, with provision for 1/2-inch electrical conduit. Solenoid valves shall be as manufactured by ASCO, Magnetrol, or equal.

2.07 DIFFERENTIAL PRESSURE TRANSMITTERS - ELECTRIC

- A. General. A single pair of wires shall provide signal and power transmission. Operating ambient temperature shall be at least -40 to +85 degrees C. Range shall be as indicated on the Schedule and shall permit remote testing and configuration by the SMART 268 hand-held configurator. Span elevation and suppression shall be provided.

Overpressure protection shall be at least 0-2000 psig. Reference accuracy shall be ± 0.075 percent of full scale span or better. Integral adjustment hydraulic or electronic damping shall be provided.

An indicating 4-digit LCD output meter shall be provided (scale as shown in the Tables). Transmitters shall have a configurable square root extractor to provide a signal proportional to flow.

- B. Construction. The transmitter enclosure shall be NEMA 4X rated except where explosion-proof (XP) is required. The process connection shall be 1/2 inch NPT. Where enclosure and wetted surface material is not indicated on the Schedule, manufacturer's standard suitable for the process fluid shall be provided. Vent drain plug shall be provided on the meter body.
- C. Accessories. Each transmitter shall be provided with a 3-valve pressure manifold (except when an isolating diaphragm is required). The manifold materials of construction shall be 316 S.S. for wetted parts. When the process fluid or pressure is not compatible with 316 stainless steel, the SI shall provide a titanium diaphragm seal manufactured to be compatible with the process fluid. The manifold shall be complete with union connector and pipe nipple.
- D. Manufacturers. Shall be manufactured by Endress and Hauser. The isolating diaphragms shall be manufactured by Ashcroft, FIT, or equal.

2.08 FLOW SWITCHES

- A. General. Flow switches shall sense an adjustable preset flowrate of fluid in a pipe and operate a SPDT switch to actuate alarms or control circuits. The switch shall be rated for 2-ampere minimum load at 120 VAC, 60 Hertz. Provide remote mounting for those installations requiring underground burial.
- B. Thermal Dispersion Type Flow Switches shall consist of a sensor probe and solid-state electronics package. The sensor probe and other wetted parts shall be stainless steel, Monel, brass or other corrosion-resistant material suitable for the fluid in the pipe. The electronics package shall be housed in a NEMA 7D enclosure with an electrical conduit connection. Process connections shall be 1 inch NPT for direct mounting into a pipe fitting with female NPT threads. The wetted materials shall be 316SS. When the process fluid or pressure is not compatible with 316 stainless steel, the SI shall provide a titanium wetted material manufactured to be compatible with the process fluid.
- C. Operating Conditions. The flow switch shall be sized and adjusted for the pipe, fluid and flowrate or velocity. Repeatability of sensing shall be within 1.0 percent of full signal range. The flow switch shall have a rangeability of 100:1 and an adjustable response time of 10-300 seconds. The supply voltage to the thermal dispersion switch shall be 120 VAC, 60 Hertz.
- D. Manufacturer. Thermal dispersion type switches shall be manufactured by Rheotherm, Fluid Components, Inc. or pre-approved equal.

2.09 RELAYS-ELECTROMAGNETIC

- A. Relays shall be provided as necessary to perform switching functions required of control panels and other control circuits.
 - 1. General Purpose Relays. This type shall be used for logic and switching power to external loads and shall be general-purpose industrial types. They shall be of the dust cover enclosed plug-in type with 8 or 11 pin, screw terminal, octal sockets. Relays shall have up to 3 pole form C contracts rated for 10 amperes at 120 VAC and be equipped with neon indicator lamps. Relays shall be as manufactured by Potter-Brumfield, or equal. Relay coils shall be surge protected by MOV (metal oxide varistor) devices rated for the operating voltage.

2. Logic Switching Relays. This type shall be used for performing logic switching within panels using up to 6 pole form C contacts per coil. These relays shall be of the plug-in telephone type with transparent plastic dust covers, indicator lamp/LED and retainer bails or springs. Contacts shall be rated for 5 amperes, suppressed inductive loads, at 28 VDC or 120 VAC. Relays shall be as manufactured by Potter-Brumfield, Square D, Allen Bradley, or equal. Relay coils shall be surge protected by MOV devices rated for the operating voltage.

2.10 PROCESS VARIABLE INDICATORS

- A. Process Variable Indicators shall be a digital display. The number of digits shall be 4, each 1/2-inch high (nominal). The displayed digits shall be Light-emitting diode (LED) and easily visible in a well-lighted control room. The reference accuracy of the display shall be plus or minus 2.0 percent or better. The indicator shall be driven by the output of a solid-state electronic amplifier. Zero and span adjustment shall be provided. The process variable indicator shall be as manufactured by Digitec, KEP, Newport, Red Lion, Action or equal. Provide indicators with appropriate supply power and input signal compatibility for the location and use designated.

2.11 TOTALIZER. Shall be as manufactured by AGM. It shall have:

- A. Mechanical Display
- B. Non-reset
- C. Powered by 24 VDC pulse

2.12 SINGLE CHANNEL LOOP CONTROLLERS.

- A. General. The controller shall be self-contained, single loop controllers with extensive configuration and application capability. Include:
 1. EXACT Self-Tuning Control to maintain loop tuning.
 2. Extensive Control Capability. Including conditioning, scaling, signal selection, and alarming.
 3. Control Applications, feed-forward and auto-select.
 4. Dynamic Compensation including lead/lag, impulse, and dead time.
 5. Single Station Cascade to minimize control panel space.
 6. A second, independent variable display
 7. Batch Control
 8. Boolean Logic Functions
- B. Manufacturer. Shall be manufactured by Foxboro.

2.13 DIGITAL CIRCULAR CHART RECORDERS.

- A. General. The Digital Circular Chart Recorder indicates and continuously records up to a wide variety of user-configurable process supporting functions such as:
 1. Alarms,
 2. Totalizers,
 3. Calculators,
 4. Curve characterizers.

- B. Construction. Recorders shall provide DC Input, Limit Alarm, Dual Setpoint, Field Configurable, 120V/240V AC power standard, 24V DC power optional. Socket mounting for quick and easy installation. Applications include on/off control (e.g. level control) or emergency shut down systems. CSA and UL Approved. Provide:
 - 1. Relay Contact Closures at a Preset DC Input Level
 - 2. Field Configurable Input Range for DC Voltage and Current
 - 3. ASIC Based Reliability with a Lifetime Warranty
- C. Manufacturer. Shall be as manufactured by Foxboro, Chessel or approved equal.

2.14 LEAK MONITOR SWITCHES AND CONTROL SYSTEM

- A. General. The leak detection system shall be the latest state-of-the-art design utilizing the proximity-type sensor assemblies and multiple-point alarm console.
- B. Construction. The sensor assembly shall be suspended at the point of detection into a containment area. The control console shall be a multiple point monitor with audible alarm and visual annunciator for each monitored area.

2.15 LEVEL SENSING SYSTEM - ULTRASONIC TYPE

- A. General. The level sensing system shall be designed to operate on the principle of sound echoing to provide level measurement without contact. Equipment as necessary to meet the requirements as set forth herein shall be included and connected so as to provide a complete and operational system.
- B. The level sensing system shall include as a minimum the following:
 - 1. False target buffer.
 - 2. Self-diagnostics.
 - 3. Keypads access to programmable parameters.
 - 4. Configurable to provide 4-20 ma, 0-10 Vdc, RS485 serial communications and up to six (6) relay outputs.
 - 5. Operation with ambient temperatures of -40° to 71°C.
 - 6. Multi-range capabilities with up to 16 point characterization.

2.16 LEVEL SENSING SYSTEM - CAPACITANCE TYPE

- A. General. The level sensing system shall be designed to operate on the principle of R.F. Capacitance to provide level measurement. Equipment as necessary to meet the requirements as set forth herein shall be included and connected so as to provide a complete and operational system.
- B. The level sensing system shall include as a minimum the following:
 - 1. NEMA 4X Integral Mount Indicator.
 - 2. Self-diagnostics.
 - 3. Keypads access to programmable parameters (If applicable).
 - 4. Configurable to provide 4-20 ma, 0-1 ma, 0-10 Vdc, RS232C/422A serial communications and up to three (3) relay outputs.

5. Operation with ambient temperatures of -40° to 71°C.
 6. NEMA 4X Remote mount transmitter except where explosion proof (XP) is specified on the schedule.
- C. The level sensing system shall include microprocessor, probe, heaters, temperature compensators, stilling well, grounds and/or heat shields as necessary to provide a complete and operational system. The system shall be as manufactured by STI/Magnetrol or pre-approved equal.

2.17 PROCESS SENSORS

- A. General. The process sensors shall be suitable for continuous monitoring of the particular process solutions. The sensors shall be supplied with analyzers specifically designed for that application.
- B. Construction. The unit shall be of solid state design and be sealed to eliminate moisture problems. The unit shall be capable of reading a range of 0-100 percent with an accuracy of $\pm 2\%$ and range expandability feature of at least 10 % of full scale. The unit shall provide a selectable response, to 90%. The unit shall provide an isolated 4-20 ma signal output and be able to operate from a 115/208 VAC, 60 Hz power supply. The control unit case shall be NEMA-4X stainless steel housing and the sample unit and sensor shall be housed in a NEMA-4X plastic case. Each of six remote analyzers shall be housed in NEMA-4X stainless steel enclosures sized to contain both analyzer and sample pump (isolated compartments), in accordance with Section 11215. Environmental control of these units is required. The unit shall have the required accessories for calibration and standardization. If required by a particular process, an ultrasonic cleaner shall be provided and shall be a submersible or flow-through as necessary.
- C. Free Chlorine analyzers shall be the as manufactured Hach, Analytical Technology, Inc. or pre-approved equal. Analyzers shall be on-line monitors using direct sensing probes. The sensor shall be the polarographic membraned type and shall not require the use of chemical reagents. Analyzer shall be powered from 120 volts, 60 Hz. Output shall be an isolated 4-20 mADC signal and shall be linear throughout the 0-19.99 mg/L of free chlorine range. Accuracy Shall be 2% or ± 10 ppb TFC, whichever is greater at pH <7.5; 2% or ± 10 ppb HOCl, whichever is greater at pH <8. Provide two adjustable alarms configurable for high and low alarming. The sensors shall be mounted so that a constant overflow assembly will automatically regulate flow past the sensor. Sensor mounting hardware shall be supplied to enable installation at each area as illustrated to provide a complete and operable system.
- D. Total Chlorine analyzers shall be the as manufactured Hach, Analytical Technology, Inc. or pre-approved equal. Analyzers shall have 0 to 5 mg/L range with automatic color/turbidity compensation. DPD (N,N-diethyl-p-phenylenediamine) colorimetry is simple and accurate, providing reliable measurement of free or total residual chlorine. Provides a programmable 4-20 mA recorder output and two user-selectable alarms with SPDT relays that signal out-of-limit test results or system problems. Range: 0 to 5mg/L free or total residual chlorine, with automatic color/turbidity compensation. Accuracy shall be $\pm 5\%$ or 0.035 mg/L as Cl₂, whichever is greater. Sample time shall be one complete sample analysis every 2-1/2 minutes
- E. The final effluent turbidity meter shall be by Hach or pre-approved equal. The Turbidimeter applies the instrument design and meets performance criteria established by the U.S. Environmental Protection Agency (USEPA) in Method 180.1, making it suitable for regulatory reporting. Incandescent light directed from the sensor head assembly down into the turbidimeter body is scattered by suspended particles in the sample. The sensor's submerged photocell detects light

light scattered at 90° from the incident beam. Sample enters the center column of the turbidimeter, rises into the measuring chamber and spills over the weir into the drain port. This configuration results in an optical flat surface free of turbulence. Range shall be 0.001-100 Nephelometric Turbidity. Accuracy Shall be $\pm 2\%$ of reading or ± 0.015 NTU (whichever is greater) from 0 to 40 NTU; $\pm 5\%$ of reading from 40 to 100 NTU.

- F. Ammonia/Monochloramine Analyzers shall be as manufactured by Hach Company or pre-approved equal. Analyzers shall be on-line, continuous monitors that measure the three critical chloramination parameters. The analyzer shall display Free Ammonia, Total Ammonia and Monochloramine measurements simultaneously. The analyzer shall be capable of measuring two separate sample streams, one every 5 minutes. Accuracy: $\pm 5\%$ of reading or ± 0.02 ppm as N whichever is greater. Outputs shall be isolated 4-20 mA DC signals (4) and shall be linear throughout the range. Outputs shall include four PID control loops. Provide two adjustable alarms configurable for high and low alarming. Sample flow shall be filtered to 22 microns or less and shall not exceed 6 mL/min.
- G. pH and ORP sensors shall be of the differential electrode technique design which uses two electrodes to compare the process value to a stable internal reference standard buffer solution. The sensor shall be 5 wire with integral preamplifier and shall have a hex shaped body to facilitate mounting. Sensors shall be Hach or pre-approved equal. Provide necessary optional hardware for connection and mounting as shown in drawings.
- H. pH and ORP Analyzers shall be single or dual as required by the process. The analyzer must accept a GLI 5-wire input and provide an isolated, range expandable 4-20 mA output signal capable of direct or reverse acting configuration. Provide two adjustable alarms configurable for high and low. pH and ORP Analyzers shall Hach or pre-approved equal.
- I. Conductivity Measurement System. The conductivity sensors shall be the Model 3700E electrodeless union-mounted, convertible style compatible with the Model E53 Electrodeless Conductivity Analyzer. The Model E53 shall be configurable to measure conductivity and % concentration. The Model E53 shall measure conductivity up to 2 Siemens/cm with an accuracy of 0.5% of span, and has eleven built-in preprogrammed concentration curves. A large backlit graphic LCD displays the measured conductivity, process temperature, two analog outputs and up to four relay contacts. Menu screens shall contain up to six full lines of text to logically guide the user through setup, calibration, and operation.

Each isolated analog output is selectable as either 0-20 mA or 4-20 mA, and voltage. Four alarm/control contacts are to be provided. The E53 is housed in an epoxy-coated, metal NEMA 4X 1/2 DIN enclosure, suitable for panel, surface or pipe mounting. The Conductivity Analyzers shall be Hach or pre-approved equal.

- J. The Dissolved Oxygen Analyzer shall be provided for advanced sensor diagnostics and simple menus to guide the operator intuitively through start-up, calibration, and general operation. One-touch air calibration shall compensate for atmospheric pressure, temperature, and salinity.
The Dissolved Oxygen Sensor shall use galvanic technology and provide a replaceable membrane cartridge. Each cartridge assembly includes a pre-installed membrane, electrolyte, and electrodes, replenishing all of the sensor's consumable parts. The sensor shall have an accuracy of 0.2% of span.
The self-cleaning option consists of a self-contained air-blast system, complete with air compressor, and is programmable to automatically clean the sensor membrane.

The DO probe and analyzer shall be manufactured by Hach model 4740SC or pre-approved equal.

- K. The alkalinity analyzer shall be a continuous-reading analyzer that utilizes m-cresol purple and bromocresol green to visualize two endpoints for colorimetric measurement of alkalinity at a wavelength of 600 nm. The measurement range shall be 1.0 to 1000.0 mg/L (parts per million) total alkalinity and 5.0 to 1000.0 mg/L phenolphthalein alkalinity as CaCO₃. The analyzer accuracy shall be $\pm 5\%$ of reading or ± 1 mg/L, whichever is greater. Precision shall be $\pm 3\%$ of reading or ± 0.6 mg/L, whichever is greater. The analyzer shall provide digital display in a numeric or graphical format. The alkalinity analyzer shall be capable of automatic calibration, cleaning and self-priming.

The analyzer shall provide continuous purge for sample to drain to assure fresh sample to the analyzer and reduce analysis lag time. The analyzer shall use an auto burette to dispense metered volumes of sample, standards and reagents. Sample, standard and reagent flow shall be directed to the detector module by a rotary valve. Sample shall be delivered to the analyzer at the pressure of 5 to 100 psig and the temperature of 5 to 50 °C. The analyzer shall be capable of grab-sample analysis without interrupting continuous sample flow to the analyzer.

Fourteen user-defined internal recorders, of which four can be used for PID control, shall be provided. Two user-selectable recorder/controller outputs of 4-20 mA, with expansion capability up to 14, shall be provided. Recorder output span shall be user-adjustable over the entire span of the analyzer. Fourteen user-defined alarms shall be provided. Alarms may be programmed for sample concentration alarms, analyzer system warning and analyzer system shutdown. Two unpowered SPDT relays, also with expansion capability up to 14, shall be provided for internal alarms. Two relay contacts shall be rated for 5A resistive load at 230 Vac.

The analyzer components shall be assembled to a NEMA-4X(indoor)/IEC 529 (IP66) plastic enclosure designed for bench, wall or panel mounting. Standards and reagents shall be isolated from analyzer electronics in separate plastic containers. Power requirement shall be 95-240 Vac, 50/60 Hz. The analyzer shall be warranted for one full year against defects in materials and workmanship and shall include a 30-day supply of standards and reagents.

The analyzer shall be designed to meet UL3101-1, CSA C22.2 No. 1010.1 and EN61010-1 (IEC 1010-1) safety standards. The analyzer shall also comply with Class A limits for radio and noise emission as specified by the FCC and EN55011 (CISPR11).

- L. Total Inorganic Phosphate, Orthophosphate, and Polyphosphate

Unit will use high resolution Ultraviolet Absorbance with a spectral range of 200- 450 NM. Enclosure finish shall be polyester urethane on 316SS. Unit will use four 4 -20 mA outputs for data communication and will have a data logger. The response time will ten minutes for all parameters. Acceptable manufacturer will be Chemscan UV-2150 or pre-approved equal

- M. Fluoride Analyzer

Analyzer will use the recognized EPA method (ASTM D 1179-04) for Fluoride analysis using and ion selective electrode. Includes reagent pH adjustment for proper sample conditioning. Analyzer has a range of 10ppb – 200 ppm and reaches 95% of reading within 2 minutes of injecting a standard solution. Accuracy is $\pm 10\%$ or 10ppb whichever is greater. Analyzer has an isolated 4 – 20 mA output and three relay outputs. NEMA 4X enclosure. Acceptable manufacturer and model is Thermo Scientific Orion Model 2109XP or pre-approved equal.

2.19 INSERT VENTURI FLOW METER

- A. General. Venturi meters shall be provided as shown on the Drawings and specified herein for measurement of water flow.
- B. Construction. Venturi tubes shall be constructed of polyester resin reinforced with glass (30% by weight) and a stainless steel throat. It shall exhibit an essentially constant flow coefficient over a 10:1 range of flow. The throat section shall have a cylindrical length equal to at least one half the throat diameter. Pressure sensing port sleeves shall be manufactured from 316 stainless steel and mounting flanges shall be 304 stainless steel. When the process fluid is not compatible with stainless steel super duplex 20 throat and fiberglass cones shall be supplied. The tube shall be designed to mount between two ANSI B16.1 Class 125 flanges. Permanent head loss shall not exceed 10% of the nominal differential pressure at maximum flow. The metering element shall not have debris collecting cavities or annular chambers, but shall have four pressure connections located 90° apart in the center flange for differential pressure instrument sensing element and sampling connections. Flange thickness shall be .75 inches.
- C. Operating Conditions. The manufacturer shall submit a certified flow versus differential curve at specified flows for approval. The manufacturer shall furnish certified data substantiating venturi tube proportions and performance. The data shall include:
 - 1. Coefficient values and tolerances.
 - 2. Effects of upstream configuration.
 - 3. Head differential as a function of flow.

The accuracy shall be $\pm 0.5\%$ of actual rate of flow corresponding to the differential produced over the range specified.

- D. Manufacturer. The tubes shall be manufactured by Primary Flow Signal (PFS), Lincoln, Rhode Island, or pre-approved equal.

2.20 RTD TEMPERATURE SENSOR

- A. General. Temperature transmitter shall be an RTD probe with a thermowell.
- B. Manufacturer. Provide platinum RTD probe Model PR-12-2-100-1/4-24-E and a High Performance Indicator Model DP41-E as manufactured by Endress and Hauser.

2.21 MAGNETIC FLOW METERS

- A. General. Magnetic meters shall use the principle of electromagnetic induction to produce a DC voltage proportional to the rate of liquid flow. Coil excitation shall be DC. The coils shall generate a magnetic field, which in turn induces a voltage in the flowing liquid, which is sensed by a pair of electrodes in contact with the liquid.

B. Construction.

1. The coils shall be protected from contact with the liquid. The electrodes shall be made of ANSI type 316 stainless steel or tantalum if 316 SS is not compatible with the process fluid and shall be provided with a minimum pre-amp input impedance of 10^{12} ohms. The meter housing shall be splash- and drip-proof and shall withstand continuous submersion up to 30 feet. The metering tube shall withstand abrasion of the liquid.
2. Unless otherwise specified, the meters shall be designed to operate from a 120 VAC, 60 Hz, single-phase power supply and a 10 percent variation in power line voltage shall not affect the meter output accuracy in excess of 0.1 percent of full scale. Power consumption shall not exceed 35 watts for meters 6 inches and smaller or 5 watts per inch of diameter for meters 8 inches and larger.
3. Each magnetic flow meter system shall have accuracy within 1 percent of rate over the application operating range indicated in the Schedule. Meters shall have a repeatability of 0.1 percent of full scale.
4. Each magnetic flow meter shall be equipped with a signal converter to transmit an analog 4-20 mA dc signal. When specified in the Schedule, a frequency and/or a scaled pulse rate (at 2 to 40 Vdc) to drive-totalling counters shall also be transmitted. The signal shall be linear with flow within the accuracy specified above. The converter shall be wall or pipe-stand mounted adjacent to the meter housing and shall be a high accuracy microprocessor converter with self-diagnostics and empty pipe detection. The converter shall be housed in a NEMA 4 aluminum housing. Local direct reading digital indicators shall be supplied. The meters shall have automatic zero correction. The manufacturer shall furnish interconnecting cable between the meter and signal converter.
5. The magnetic flow meters shall be of the short-form type with a laying length approximately 1-1/2 times the diameter for line sizes 3 inches and larger. Meters shall be designed with end connections as shown on the drawings except meters with line sizes less than 3 inches shall have 150-pound ANSI flanges. Field coils shall be either completely encapsulated in the meter lining material or the meter tube shall be of 304 S.S. with a suitable liner. A suitable protective shield shall be provided at each end of the liner for withstanding the scouring velocities of the process fluid at the maximum flow-rates.

C. Grounding. A grounding circuit shall be provided for each magnetic meter. Provide grounding rings, grounding electrodes or protective shields to serve as a liquid ground.

D. Manufacturer. Magnetic flow meters shall be as manufactured by Endress and Hauser or pre-approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Field mounted elements shall be installed, calibrated, and started up in strict compliance with the manufacturer's requirements and recommendations. Conflicts between the manufacturer's requirements and recommendations and these specifications or the drawings shall be presented to the Engineer for resolution before any affected work is started. The Systems Integrator as appropriate for the application shall certify installed equipment and process and that it is installed correctly.

- B. Connections of instruments to process piping shall include, as close as practical to the point of connection, a tight closing block valve suitable for the maximum process pressure and temperature and for the material involved. If connections are of threaded or welded pipe there shall be a union or flanged connection located to facilitate disassembly of the connection and removal of the instrument without interrupting process operation.
- C. Instruments shall be protected and isolated from vibration, temperature extremes, radiant heat, rain or falling water, and similar adverse conditions. Forced ventilation and temperature controls shall be provided for analyzers and instruments located outside or in environments subject to extreme temperature or adverse conditions.
- D. Impulse lines of pressure or pressure differential instruments shall be as short as practical and shall be installed with a minimum slope of 1-inch per foot (1:12) downward toward the instrument in liquid system and upward toward the instrument in gaseous systems. If this preferred direction of slope cannot be maintained, the Company shall submit for approval an installation configuration utilizing traps, drains, and/or vents at high and low points, which will ensure freedom from mixed phase offset effects and provide ease of purging or draining. Heat tracing is required for exposed liquid filled lines.
- E. Field mounted elements shall be marked with data required for calibration such as location of adjustments, span, offset, zero suppression, and test voltages. If such data are not provided in permanent markings or on the manufacturer nameplate, a durable tag or label shall be affixed in a protected location, which will become readily visible in the normal course of servicing the instrument.
- F. Provide field mounted analyzers with adequate drainage for up to 1 gpm without any ponding around the units.
- G. Security and Fire protection equipment shall be installed by an authorized representative of the manufacturer.
 - 1. Equipment, including wire and cable, shall be installed in strict accordance with the manufacturer's instruction and recommendations. Consult installer for wiring diagrams, schematics, sizes, outlets, etc., before installing conduits.
 - 2. Conduit. The electrical contractor shall provide a complete conduit system between equipment in accordance with shop drawings. Junction boxes shall be labeled as "CCTV" with decal or approved markings and comply with local, state and national codes.
 - 3. Equipment shall be held firmly in place. Fastening and supports shall be adequate to support the loads with a safety factor of five.
 - 4. Device Box Mounting. Unless otherwise noted on the Drawings, plans or specifications, the installer will provide recommended mounting heights, type of boxes required and other specific requirements as part of their shop drawings.
- H. The Company shall provide the services of the manufacturer's field representatives to supervise and test the installation of the security and fire protection equipment.
 - 1. Equipment manufacturers shall provide the services of a qualified factory representative to supervise installation of the equipment for whatever time is required. Equipment shall be initially operated in the presence of the representative.
 - 2. Upon completion of equipment installation, the manufacturer shall issue a certificate that the equipment has been properly installed.

3. A minimum of 1 day shall be provided for field acceptance tests.

3.02 INSTALLATION, CALIBRATION, TESTING, START-UP AND INSTRUCTION:

A. General

1. Under the supervision of the Single Systems Integrator, all systems specified in this Section shall be installed, connected, calibrated and tested, and in coordination with the City, shall be started to place the processes in operation. This shall include final calibration in concert with equipment specified elsewhere in these Specifications, including pumps, valves, as well as certain existing equipment.
2. Ladder Logic Review: The contractor shall submit the PLC ladder logic for review by the City Engineer. The ladder logic shall provide a descriptive name for every relay coil and input, and a functional description for every (3) rungs for ladder logic. The Company shall provide (5) days services of the ladder logic programmer to review the logic with the City at the City's office in Hialeah. The review shall be conducted and all comments incorporated before the INTERLOCK TESTING, LOOP VALIDATION TESTING AND GRAPHICAL SCREEN TESTING are started.
3. Equipment Locations: The monitoring and control system configurations indicated are diagrammatic. The locations of equipment are approximate. The exact locations and routing of wiring and cables shall be governed by structural conditions and physical interferences and by the location of electrical terminations on equipment. All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. Where job conditions require reasonable changes in approximated locations and arrangements, or when the City exercises the right to require changes in location of equipment which do not impact material quantities or cause material rework, the Company shall make such changes without additional cost to the City.
4. Conduit, Cables, and Field Wiring shall be installed as follows:
 - a. All conduit shall be provided under Division 16 without delay to the Design-Build Work of Division 13.
 - b. All 4-20 mA signal circuits, process equipment control wiring, signal wiring to field instruments, DCS input and output wiring and other field wiring and cables shall be provided under Division 16.
 - c. All DCS equipment cables, fiber optic cables, network cables, data highway communication networks shall be provided under Division 13.
 - d. All terminations and wire identification at Instrumentation and Controls equipment furnished under this or any other Division shall be provided under Division 13.
 - e. All wires from field instruments, and power supplies shall be under Division 16. All other terminations shall be under Division 13.

B. Installation, Connection and Wiring Test

1. The Company shall install and connect all field mounted components and assemblies under the criteria imposed in Part 1, 1.03, herein. The installation personnel shall be provided with a final reviewed copy of the Shop Drawings and data.
2. The instrument process sensing lines and air signal tubing shall, in general, be installed in a similar manner to the installation of conduit specified under Section 16050 Motors. Individual tubes shall be run parallel and near the surfaces from which they are supported.
3. Supports shall be used at intervals of not more than 3 feet of rigid tubing.

4. Bends shall be formed with the proper tool and to uniform radii and shall be made without deforming or thinning the walls of the tubing. Plastic clips shall be used to hold individual plastic tubes parallel. Ends of tubing shall be square cut and cleaned before being inserted in the fittings. Bulkhead fittings shall be provided at all panels.
5. The Company shall have a technical field representative of the Single Systems Integrator to instruct these installation personnel on any and all installation requirements; thereafter, the technical field representative shall be readily available by telephone to answer questions and supply clarification when needed by the installation personnel.
6. Where primary elements (supplied by Single Systems Integrator) shall be part of a mechanical system, the Single Systems Integrator shall coordinate the installation of the primary elements with the mechanical system manufacturer.
7. Finally, after all installation and connection work has been completed, the technical field representative shall conduct a wiring test of all instruments and control components to check for correctness, verifying polarity of electric power and signal connections, making sure all process connections are free of leaks, and all such similar details.
8. The technical field representative shall certify in writing to the Company that for each loop or system he has completed such check out and that any discrepancies have been corrected by the installation personnel.
9. The field representative of the Single Systems Integrator shall coordinate all work required to interface the new equipment and control devices with the existing equipment, including all required modifications to existing equipment and related devices.

C. Calibration and Calibration Test

1. All instruments and systems shall be calibrated after installation, and checked in conformance with the component manufacturer's written instructions.
2. This shall provide that those components having adjustable features are set carefully for the specific conditions and applications of this installation, and that the components and/or systems are within the specified limits of accuracy. Defective elements which cannot achieve proper calibration or accuracy, either individually or within a system, shall be replaced. This calibration work and Calibration test shall be accomplished by the technical field representatives of the Single Systems Integrator who shall certify in writing to the Company that for each loop or system all calibrations have been made and that all instruments are ready to operate. Each instrument calibration sheet shall provide the following information and a space for sign-off on individual items and on the completed unit:
 - a. Project name.
 - b. Loop number.
 - c. Tag number.
 - d. Manufacturer.
 - e. Model number.
 - f. Serial number.
 - g. Calibration range.
 - h. Calibration data: Input, output, and error at 10 percent, 50 percent and 90 percent of span.
 - i. Switch setting, contact action, and deadband for discrete elements.
 - j. Space for comments.
 - k. Space for sign-off by Single Systems Integrator and date.

- l. Test equipment used and associated serial numbers.
- m. Calibration Manuals shall be supplied by the Company for each instrument in which calibration is necessary. The Company shall provide any special instruments required for calibration.
3. Proof of Conformance - The burden of proof of conformance to specified accuracy and performance is on the Company using its designated Single Systems Integrator. The Company's designer shall supply necessary test equipment and technical personnel if called upon to prove accuracy and/or performance, at no separate additional cost to the City, wherever reasonable doubt or evidence of malfunction or poor performance may appear within the guarantee period.

D. Interlock Testing, Loop Validation Testing and Graphical Screen Testing

1. Loop Testing General: Individual instrument loop diagrams (per ISA Standard S5.4 - Instrument Loop Diagrams) expanded format, shall be submitted to the City Engineer for review prior to the loop tests. The Company shall notify the City Engineer of scheduled tests a minimum of 30 days prior to the estimated completion date of installation and wiring of the DCS. After the City Engineer 's review of the submitted loop diagrams for correctness and compliance with the specifications, loop testing shall proceed. The loop check shall be witnessed by the City Engineer.
2. Interlocks and Interlock test: All hardware and software interlocks between the instrumentation and the motor control circuits, control circuits of variable-speed controllers and packaged equipment controls shall be checked to the maximum extent possible. Interlock testing shall be witnessed by the City Engineer after completion of the wiring test.
3. Loop Validation Test: Controllers and electronic function modules shall be field tested and exercised to demonstrate correct operation. All control loops shall be checked under simulated operating conditions by impressing input signals at the primary control elements and observing appropriate responses of the respective control and monitoring elements, final control elements, and the graphic displays associated with the DCS. Actual signals shall be used wherever available. Following any necessary corrections, the loops shall be retested. Each analog network shall be tested by applying simulated analog or discrete inputs to the first element of an analog network. For networks which incorporate analog elements, simulated sensor inputs corresponding to 20, 50, and 100% of span shall be applied, and the resulting element outputs monitored to verify compliance. Provisional settings shall be made on controllers and alarms during analog loop tests. All loop Validation test data shall be recorded on test forms. Loop Validation testing shall be witnessed by the City Engineer after completion of the wiring test, calibration test, and Interlock test.
4. Each loop confirmation sheet shall cite the following information and shall provide spaces for sign-off on individual items and on the complete loop by the Single Systems Integrator:
 - a. Project name.
 - b. Loop number.
 - c. Tag number, description, manufacturer and model number for each element.
 - d. Installation bulletin number.
 - e. Specification sheet number.
 - f. Graphic Objects tested.
 - g. Adjustment check.
 - h. Space for comments.
 - i. Space for loop sign-off by Instrumentation Company and date.

- j. Space for City Engineer witness signature and date.
 - 5. Graphical Screen Test: The graphical screens shall be tested for each alarm, status and control point. This testing shall be conducted at the same time as the Interlock test and Loop Validation test. All graphical screen testing shall be recorded on test forms. Graphical screen testing shall be witnessed by the City Engineer.
 - 6. When all Interlock, Loop Validation, and Graphical Screen tests have been successfully completed for all individual instruments, all separate analog control networks, and all graphical objects, a certified copy of all test forms signed by the City Engineer or the City Engineer's representative as a witness, with test data entered, shall be submitted to the City Engineer together with a clear and unequivocal statement that all instrumentation has been successfully calibrated, inspected, and tested.
 - 7. Schedule: The scheduling of tests shall be coordinated by the Company among all parties involved so that the tests may proceed without delays or disruption by incomplete work.
- E. Precommissioning
- 1. General: Precommissioning shall commence after acceptance of all wire test, calibration tests and loop tests, and all inspections have demonstrated that the instrumentation and control system complies with all Service Contract requirements. Precommissioning shall demonstrate proper operation of all systems with process equipment operating over full operating ranges under conditions as closely resembling actual operating conditions as possible.
 - 2. Precommissioning Procedures and Documentation: All precommissioning and test activities shall follow detailed test procedures and check lists accepted by the City. All test data shall be acquired using equipment as required and shall be recorded on test forms accepted by the City, which include calculated tolerance limits for each step. Completion of all system precommissioning and test activities shall be documented by a certified report, including all test forms with test data entered, delivered to the City with a clear and unequivocal statement that all system precommissioning and test requirements have been satisfied.
 - 3. Operational Validation: Where feasible, system precommissioning activities shall include the use of water to establish service conditions that simulate, to the greatest extent possible, normal final control element operating conditions in terms of applied process loads, operating ranges, and environmental conditions. Final control elements, control panels, and ancillary equipment shall be tested under start-up and steady-state operating conditions to verify that proper and stable control is achieved using motor control center and local field mounted control circuits. All hardwired and software control circuit interlocks and alarms shall be operational. The control of final control elements and ancillary equipment shall be tested using both manual and automatic (where provided) control circuits. The stable steady-state operation of final control elements running under the control of field mounted automatic analog controllers or software based controllers shall be assured by adjusting the controllers as required to eliminate oscillatory final control element operation.
- F. Performance Test
- 1. The entire DCS shall operate for 30 days without failure that requires a system reboot of the PLCs or halts operation of the plant.
 - 2. The Company shall furnish all necessary support staff as required to operate the system and to satisfy the repair or replacement requirements.
 - 3. If any component fails during the performance test, it shall be repaired or replaced and the Controls and PLCs shall be restarted on another 30 day period.

4. The contractor shall provide a minimum of 40hrs a week for (4) weeks of on site staff of one man during the 30 day test.

G. Start-Up and Instruction

1. When all systems are assessed by the Company to have been successfully carried through complete loop tests and precommission test with a minimum of simulation, and the City concurs in this assessment, plant start-up by the City's operating personnel can follow. For a minimum of (10) working days time, prior to start-up, operating and maintenance personnel shall be instructed in the functions and operation of each system and shall be shown the various adjustable and set point features which may require readjustment, resetting or checking, re-calibration or maintenance by them from time to time.
2. This instruction shall be scheduled at a time arranged with the City at least two (2) weeks in advance.
3. Instruction shall be given by qualified persons who have been made familiar in advance with the systems in this plant.
4. All equipment shall be checked during the first year of operation at intervals of three months for a period of not less than one day or as may be required to correct any defects to the satisfaction of the City.

H. On-Site Supervision:

The Company shall furnish the services of an on-site resident engineer to supervise and coordinate installation, adjustment, testing, and start-up of the DCS. The resident engineer shall be present during the total period required to effect a complete operating system. The resident engineer shall be familiar with the PLC Ladder Logic program and the HMI Graphical displays and shall be qualified to make revisions to the PLC programs and the HMI configuration.

I. Acceptance

1. For the purpose of this Section, the following conditions shall be fulfilled before the Design-Build Work is considered substantially complete.
2. All submittals have been completed and approved. The Controls and Instrumentation has been calibrated, loop tested and precommissioned.
3. All required spare parts and expendable supplies and test equipment have been delivered to the City.
4. The performance test has been successfully completed.
5. All punch list items have been corrected.
6. All record drawings in both hard copy and electronic format have been submitted.
7. Annotated copy of ladder logic has been submitted to the City. A copy of the ladder logic and ladder logic programming software reside on (1) workstation.
8. Database for HMI has been submitted to the City Engineer. A copy of the HMI database and graphical screens and the HMI configuration software and tools reside on (1) workstation.
9. Revisions to the City's Manuals that may have resulted from the field tests have been made and reviewed.
10. All debris associated with installation of instrumentation has been removed.
11. All probes, elements, sample lines, transmitters, tubing, and enclosures have been cleaned and are in like-new condition.

3.03 CONTROL STRATEGIES:

A. General

1. The control strategies are written descriptions of the programming required to implement regulatory and sequential control of the unit processes. Control strategies shall fully reside in the memory of the designated PLC. Coefficients pertaining to control strategies shall be modifiable through the operator interface in the monitoring / control mode.
2. The Single Systems Integrator shall include a programmer on-site to fine tune control systems and make minor software modifications in order to resolve any logic discrepancies encountered during startup as directed by the City Engineer. This time shall not be used to correct contract deficiencies. This shall be part of the bid package with no additional cost to the City.

B. The Control System Shall Provide the Following Levels Of Operation

1. Operator level, that shall provide control of all plant equipment and making backups and archives, and booting the system.
2. Engineer level that shall provide the functions of the operator level and privileges to set all Tunable Values.
3. User level, that shall provide a view only of the control system

C. Control Descriptions Common Functions

1. Common functions that are generally applicable to all loops or to many similar loops are described under the heading "General Control Loop Functions." These functions are not repeated in the descriptions for each individual control descriptions.

2. General Control Loop Functions

The following terms are used in the descriptions of PLC functions:

- a. Operator Settings: Operator set or entered values shall be constants that are adjustable or set from operator displays. Examples of operator set or entered values are controller set points, batch set points, etc. Specific values that are required to be operator set are noted in the process control descriptions. All process control set-points such as loop gain, manual speed, and setpoint shall be entered as a (3) digit value or a slider bar.
- b. Tunable Values: Tunable values are constants that are adjustable at engineer level displays from the HMI without requiring any software reconfiguration. These values are not adjustable from operator level displays. All PID controllers shall have tunable values for proportional gain, reset time, and derivative rate of change. All such values shall be set only at the engineering level.

3. The Following General PLC and/or HMI Functions Shall Be Provided

- a. All analog and discrete inputs and outputs to the PLC shall be displayed at the HMI graphical process screens. Both RUNNING, READY, OPEN, CLOSE, and OFF input states shall be displayed. The HMI shall also display all pertinent internal values such as commanded state of outputs, countdown timer values, software interlock bits and any other program functions which are useful to the operator in understanding the present state of the automatic functions of any given process. The Company shall provide a list of such functions at the Graphics Meeting No. 2 as specified in Paragraph 3.03.
- b. All analog inputs shall have instrument failure alarms when the input is below 0 percent or above 100 percent for a tunable time initially set at 10 seconds..
- c. All discrete FAIL inputs shall be alarmed. Other discrete inputs shall be alarmed as noted

noted in the control descriptions. The following alarms shall be displayed on the graphic screens in flashing RED letters next to the tank, pump or other associated equipment:

- i. High/Low tank alarms.
- ii. High/Low analog Pressure alarms.
- iii. High/Low analog Process alarms.
- d. Where alarms are specified in the control descriptions, alarms shall be initiated from the applicable inputs. If discrete inputs are not available, the specified alarms shall be initiated from the applicable analog input. Alarms shall be displayed on the Alarm summary screen showing all alarms that have not been acknowledged as flashing red, alarms that have been acknowledged as steady yellow. A PLC failure and certain alarms shall also appear on the graphical process screens. All alarms shall be time stamped with an event time and date and users name and time with the alarm was acknowledged.
- e. All analog inputs shall be trended in a trend display. All trend displays shall have the appearance of a traditional paper strip chart recorder. As a minimum trends shall display the process variable, the transmitter tag, English descriptions, and the units for both axes. For variables which are controlled by the PLC, both the setpoint and the controlled process variable shall be displayed on the same trend. On trends where multiple variable are displayed, separate and distinct colors shall be used for each variable along with a color key with English descriptions defining each variable. Data for all trends shall be logged for 120 days. At the end of 120 days or a backup operation the values shall be deleted. A screen shall be provided to backup and review analog trend and to step the operator through the process of backing up or reviewing a set of trends. The operators shall be able to backup trends to the write-able CD-ROM drive in 60 day increments and review trends stored on the CD-ROMs. At prompt shall alert the operator that 60 days have passed since the last backup.
- f. All flow inputs and equipment run times shall be totalized and recorded. All totalized values shall be displayed and archived in the historical database. All daily totalizers shall be reset at midnight each day. Each total shall be displayed with the current total for the day and yesterdays total and shall be grouped together on as set of screens. Provide a screen displaying the run time in units of 100 hours of each motor connected to the PLCs.
- g. Displays shall be grouped functionally for ease of operation. Both analog and discrete functions associated with an item of equipment or a group of equipment shall be provided on the same display.
- h. Unless otherwise stated or shown, all discrete outputs shall be maintained outputs. For START/STOP PLC functions, the PLC shall issue a maintained START command until a RUNNING state is no longer detected or when a STOP command is issued. When a momentary command is required, the PLC shall issue the command for two (2) seconds, then remove the signal.
- i. For equipment that is controllable from the PLC, a control mode status signal will be sent to the PLC to indicate when the PLC is allowed to control the equipment. The PLC shall monitor the control mode status (LOCAL/ REMOTE) and attempt to control only the equipment which is in the REMOTE mode.
- j. For equipment that the PLC is allowed to control, the PLC shall provide a FAIL TO RUN alarm if the equipment fails to comply with a PLC command signal (START, STOP, OPEN, CLOSE) that has been present for more than a tunable time period. In this event, the command shall be removed subsequent to the expiration of the tunable time period.

- k. All PID control functions (P, PI, and PID) shall be provided with standard analog controller functions and operator interfaces including, but not limited to, the following;
 - i. AUTO/MANUAL mode selection: In AUTO, the output of controller shall be based on the PID control calculation. In MANUAL, the output of the controller shall be operator adjustable. Transfer between operational modes shall be bumpless.
 - ii. LOCAL/REMOTE set point selection: In LOCAL, the set point shall be operator adjustable from the equipment. In REMOTE, the set point shall be adjustable from a REMOTE set point input.
 - iii. Set point, process variable, and controller output shall be displayed.
 - iv. Operator entered set-points shall be limited at the HMI level so that “illogical” setpoint overlap does not occur. (i.e. A lead pump start setpoint cannot be higher than the lag pump start setpoint in a pump down control system. Likewise, start set-points must always be higher than stop set-points for a given pump)
 - v. Provisions shall be included to prevent reset windup.
 - vi. Loop tuning parameters: The HMI/PLC interface shall be configured to allow operators with supervisory level security clearance access to all loop tuning parameters from the HMI for any control loop. Changing loop tuning parameter SHALL NOT require reconfiguring, reprogramming, or otherwise reloading the PLC program. All changes to any loop tuning parameters will be logged to the historical database. The database should record both the values before and after changes are made.
- 4. When equipment is tagged OUT OF SERVICE by the operator, PLCs shall inhibited all alarms and associated equipment alarms until the tagged equipment is re-tagged IN SERVICE.
- 5. Software interlocks and inhibits: The HMI shall display software interlocks or inhibits which prevent a device from normal operation near the graphic display of a device or on the applicable process display screen. The intention is to inform the operator why the PLC is not running a device as would normally be expected. An example would be would be a pump that normally runs continuously which has been inhibited from running by the PLC due to a low level condition in that pump’s supply tank. A message would be displayed near the graphic of this pumps reading, “INHIBITED – LOW LEVEL IN SUPPLY TANK.”
- 6. Forced Values: The operator shall be able to force a value for any measured or calculated analog process variable which is used by the PLC for process control if the equipment has been set to out of service. Any value which has been forced should be clearly displayed as such on any graphics that the value may appear on, or may be related to. Forced values shall be logged to the historical database as low priority alarms so the operators may easily track all values currently forced at the plant. The objective is to minimize the impact of instruments normally used for process control, which have failed or have been taken out of service. For example, if the plant influent meter has failed, since all chemical feeds are paced from this meter, it is desired to immediately give the PLC a “bogey” value for influent flow so normal automatic controls may be resumed.

7. Overview Screens: The following overview screens shall be provided:
 - a. Pump Station Status; a screen to display in text based format, important plant parameters such as the status of the drainage pumps and seepage pumps, cannel levels, head loss across each bar screen, and fuel tank levels.
 - b. Main Menu Screen; a screen to display the title of each process screen with a hot button to jump to or between each process screen.
 - c. Trend Screen; a screen to display a title for each trend or group of trends with a hot button to jump to each trend.

3.04 WORKSTATION GRAPHICS GENERATION AND REPORTS:

It is the responsibility of the Company to configure the workstations and to develop, design, engineer, configure and test all of the CRT-based graphic displays required for this project. All of this work shall take into account the specific needs of the end user. In order to facilitate this work the Company shall conduct the following meetings with the City groups:

A. Graphics Meeting No. 1

1. The Company shall chair and develop an agenda for a meeting which shall address the basic criteria to be adhered to in the configuration and development of CRT-based graphic displays. At this meeting, which shall be attended by plant managerial personnel, the Company shall distribute sample display formats for illustration purposes. As a minimum, this meeting shall address the following issues:
 - a. All In-plant and remote site areas and conventions for identifying tag names and descriptors.
 - b. Designation of groups within each plant area along with tag names and descriptors.
 - c. The assignment of individual control loops and inputs to specific groups.
 - d. Organization of the systems' universal display hierarchy.
 - e. Paging schemes to be used to enable the movement from one display to another.
 - f. An itemization of the type of display to be used at each level in the graphic hierarchy (e.g., pre-formatted displays, templates, custom graphics, etc.)
 - g. Color convention to be employed on all graphics for the annotation of various status information, differentiation between alarms on the basis of alarm priority, background colors, static field colorization and dynamic field colorization.
 - h. The utilization of blinking and conditional text.
 - i. Definition of graphic symbolism to be used on the project. This listing shall include but not be limited to symbols to be used for process instrumentation, process equipment, piping, vessels and valves, All symbolism must be specific as opposed to generic in that shapes must define both function and type (e.g., specific symbols for each valve design, each pump design, each type of flow meter, etc.). If the Company's library of shapes does not adequately describe plant or pipeline conditions, the Company shall develop additional shapes to meet the plants or pipelines requirements.
 - j. Definition of all display select commands that enable the operator to move within the display hierarchy.
 - k. The utilization of cursor movement commands which enable the operator to move within a display.

- l. Definition of control input commands which enable the operator to interact with faceplates control stations and custom graphic displays to implement control outputs/functions.
- m. Definition of data input commands which enable the operator to enter numeric values into the PLC system.
- n. Definition of the utilization of “poke” points or fields which are dynamically sensitive to operator inputs to facilitate operator entry directly into graphic displays.
- o. A review of graphic generation procedures.
2. Subsequent to the adjournment of Graphics Meeting No. 1 the Company shall prepare and formalize a document titled “GRAPHICS CRITERIA” which shall contain detailed meeting minutes and a definition of all graphic guidelines to be adhered to. This report shall be supplemented by graphic examples which illustrate the incorporation and application of each graphic criteria. The report shall be submitted within 30 calendar days of the meeting’s adjournment.

B. Graphics Meeting No. 2

1. Subsequent to the finalization of the overall system-wide graphics criteria, the Company shall develop graphic packages for all of the workstations being furnished under this project. At this meeting the Company shall submit 5 copies including:
 - a. A review of the graphic package developed for the process areas for content and completeness.
 - b. A review of all data fields that display automatically updated process information.
 - c. A review of all required input commands associated with the graphic access and control manipulation.
 - d. The color standards, and the point naming conventions
2. Subsequent to the adjournment of graphics meeting No. 2 the Company shall prepare a formalized submittal of the graphic package for review along with the detailed meeting minutes. The report shall be submitted within 30 calendar days of the meeting’s adjournment. The Company shall allow 2 days for each meeting.

The following CRT based graphic displays shall be developed for this project (as a minimum):

- a. All plant processes including all interfaces to the PLCs of this project.
- b. All group alarm displays.
- c. All control loop tuning displays.
- d. All analog faceplate displays.
- e. All key macro icon displays.
- f. All database archiving control displays.
- g. All customer displays for operator set point entry and recipe displays.
- h. All historical trending displays.
- i. Control system network configuration and diagnostics display.
- j. Redundant communication diagnostics and control display.
- k. Redundant master nodes diagnostic and control display.
- l. All local nodes diagnostic display (include PLC's, Operator Interfacing Units and Instruments).

C. Reports

The Single I&C Company shall program the following reports to be displayed on the screen and printed at the request of the Operator:

1. Weekly Run time report of all equipment.
2. Weekly Fuel usage report based on Day tank levels for the Drainage Pumps.
3. Weekly operations report for the seepage pumps showing the time weighted average speed each the pumps and total run time of each pump.
4. Weekly Plant operations report showing the total volume of water that was pumped and the weighted average differential level that the water pumped.
5. The City Engineer shall provide the Single Systems Integrator an algorithm to determine the station flow based on the number of pumps running, the pump curve, the pump operating speed, and the level of the canals. The Single Systems Integrator shall provide a program in the PLC. The Company shall provide daily report showing the hourly flow and hourly peak flow.

END OF SECTION

SECTION 13322

PLANT OPERATING AND MONITORING SYSTEM

PART 1 - GENERAL

- A. Requirements specified in the conditions of the Service Contract and Division 1 form a part of this section.

1.01 DESCRIPTION

- A. Scope of Work:
 - 1. This section covers the furnishing and installing of a coordinated Control, Monitor and Alarm System including applicable specified operator interface hardware, input/output hardware, input devices, fiber optic cabling and devices, accessories or appurtenances required for proper operation of the system.
 - 2. Equipment supplied for this system shall be "off-the-shelf" standard items stocked by vendor or distributor. There will be no exceptions to this stocking requirement. The first stage submittal shall include the name and telephone number of the purchase point for each item submitted.
 - 3. Supplementing this section, the drawings indicate locations and arrangements of equipment, block diagrams for the system configuration and input/output points regarding connection and interface with other equipment. Refer to P&ID drawings, related equipment section descriptions and the operational sequence descriptions for interlock and control functions.
 - 4. The Plant ICM system, SCADA system and PLC-to-PC interconnects are based on an Ethernet network. The Plant ICM system shall include Fiber optic interconnect to the in-plant Supervisory Control and Data Acquisition (SCADA) system located in the DBO WTP and the PLC system being supplied this contract by the City. A thorough examination of the proposed system architecture, equipment and interconnect is required by the Systems Integrator prior to bid.
- B. Related Work Described Elsewhere: Other sections directly related to work covered in this section include the following:
 - 1. Shop drawings, working drawings and samples: Appendix 5 of the Service Contract.
 - 2. System Integration and Instrumentation: Division 13, Section series.
 - 3. Equipment: Division 11, Section series.
 - 4. Mechanical: Division 15, Section series.
 - 5. Electrical: Section 16, Section series.

1.02 REFERENCES

- A. General Equipment Material Stipulations: General equipment and material stipulations shall apply to equipment furnished under this section.
- B. Governing Standards: The codes and standards generally applicable to the work of this section are listed herein. Codes and standards current at the time of bid shall be used.
ANSI - American National Standards Institute (Including ISA)

IEEE - Institute of Electrical and Electronics Engineers
NEMA - National Electrical Manufacturers Association
UL - Underwriters Laboratory
ETL - Electrical Testing Laboratory

1.03 COORDINATION

- A. Systems supplied under this section shall be designed and coordinated for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications. Equipment shall be designed and installed in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the manufacturer and the related equipment manufacturer.
- B. Related equipment and materials can include, but will not be limited to, instrumentation, valve control, valve monitoring, valve operators, chemical feeders, analytical measuring devices, fiber optic cables, conduit and electrical cable as described in other specifications.
- C. Review of drawings submitted prior to the final determination of related equipment shall not relieve the system supplier from supplying operational systems in full compliance with the specific requirements of the related equipment.
- D. Coordination with other contractors, review of related equipment submittals and supervision of installation shall be provided by the Systems Integrator before and during construction.
- E. Data acquisition/control system requirements and peripherals shall be coordinated with Division 13, Instrumentation, Division 11, Division 15 and Division 16, Electrical.

1.04 QUALITY ASSURANCE

- A. The functional and manufacturing quality of any equipment substitution must be equal to or greater than the specified. The system shall undergo quality assurance, component, unit, subsystem, and system tests. These tests shall include, but not be limited to the field acceptance test. The system supplier shall notify the City Engineer and the City in writing at least 14 days prior to the proposed date for commencing the tests, so representatives of the City may be present.
- B. Field Acceptance Testing:
 - 1. After installation of the system, verification of Tag points, City Engineer / City developed screens, City Engineer / City developed programming and interconnect checkout by the system supplier's personnel, a field acceptance test shall be performed.
 - 2. The field acceptance test shall consist of fifteen days during which the system shall run continuously without loss of basic functions. Basic functions are defined as those listed in this specification as items required for operational monitoring, control and reporting including system logic, condition control logic, trending, historical reporting, network communications, and controller communications. Failure of redundant equipment shall not be considered as downtime provided automatic fail-over occurs as specified herein and, in the opinion of the City Engineer, the failure was not caused by deficiency in design or installation.

1.05 SUBMITTALS

- A. Drawings and Data: Complete dimensional, assembly, and installation drawings, wiring and schematic diagrams; and details, specifications and data covering the materials used and the parts, devices and accessories forming a part of the system furnished shall be submitted in accordance with Appendix 5 of the Service Contract, unless more stringent requirements are specified herein. Submittal data shall be grouped and submitted in three separate stages. Each stage submittal shall be substantially complete. Individual drawings and data sheets submitted at random intervals shall not be accepted for review. Equipment tag numbers or identifications indicated on the drawings shall be referenced in every instance where applicable.
1. First Stage Submittal: The first stage submittal shall include the following items:
 - a. Produce catalog cut sheets on hardware items, shall be clearly marked to show the applicable model number, optional features, tag number (as listed on the P&IDs) and intended service of each device.
 - b. A detailed list of any exceptions, functional differences, ratings or discrepancies between the supplier's proposed system and the contract requirements. Any proposed deviations from contract specifications must receive written approval from the City Engineer prior to purchase and implementation.
 - c. A detailed list of spares, including instrumentation, control panel, and accessories shall be provided. Include current price of items submitted.
 2. Second Stage Submittal: If no exceptions or substitutions to the specified equipment are to be suggested, at the supplier's option, the stage one (1) and stage two (2) submittals may be combined. Before any equipment is released for shipment to the job site or before factory testing is scheduled, the following data shall be submitted and approved.
 - a. Functional descriptions of software modules are required by the specifications and shall be furnished as part of the City provided system. Software module (control algorithms for each process) descriptions shall be marked with the applicable specification paragraph and equipment Tag numbers of applicable inputs and controlled outputs. The City / City Engineer shall include a fully documented program of systems submitted.
 - b. Provide wiring and installation drawings for inter-connecting wiring between components of the system furnished and for interconnecting wiring between the related equipment and the equipment furnished under this section. The Systems Integrator shall assign identification to each component in the system not identified by the P&ID, associated drawings, or specifications and include that identification in his submittal. Wiring diagrams shall show complete circuits, identify components by Tag number and indicate terminations, connections, including isolators, power supplies, and surge protection devices. If panel terminal designations, inter-device connections, device features and options, or other features are modified as a result of the fabrication process or field installation, revised drawings shall be resubmitted and approved prior to shipment of the equipment to the job-site.
 3. Third Stage Submittal:
 - a. Complete system documentation, in the form of Operation and Maintenance Manuals, shall be provided. Operation and Maintenance Manuals shall include complete product instruction books for each item of equipment furnished. A printout of screens suitably describing the screen and its' control capabilities shall be furnished by the City. Where instruction booklets cover more than one specific model or range of device, product data sheets shall be included which indicate the device model number and other special features. Additionally, O&M text shall be supplied on magnetic media in Word and

drawings in AutoCad format. Magnetic media is defined as CD-ROMs, ZIP drive cartridges or 3.5 disks.

- b. The City shall furnish complete documentation on software provided with the systems specified herein. Software documentation shall consist of the following principal items:
 - 1) One (1) backup set of any integrated circuit or solid-state memory based plug-in firmware used (each system).
 - 2) Two (2) complete backup copies of system and application software in object format provided on magnetic media. (Where applicable)
 - 3) Two (2) complete backup copies of system and application software in source code format provided on magnetic media (if applicable).
 - 4) Two (2) complete copies of the system data base on magnetic media plus two printed copies.
 - 5) Two (2) sets of user reference manuals for system and application software provided.
 - 6) Two (2) sets of written as-built reference documentation for special software provided specifically for this contract.
 - 7) Two (2) printed copies of programmable controller ladder diagrams, showing address numbers, rung reference numbers, cross references, matrices and reset register values. Ladder diagram documentation shall include commentaries describing the purpose of each page, ladder sequence, rung, register, matrix, contact, coil and timer. The formulas used for algorithms shall be printed or displayed at that rung. The documentation shall include a description of the expected operation of each control sequence.
 - 8) Two (2) copies of the ladder diagrams on magnetic media compatible with the programming software specified.
 - 9) Two (2) printed copies of tables or schedules listing utilized I/O relay addresses, timers, counters, and register addresses and values (both the PLC and HMI programs).

- B. Instrumentation Test Procedures: The instrumentation system supplier (the Systems Integrator) shall prepare a detailed, step-by-step test procedure to be approved by the City and the City Engineer which shall demonstrate conformance of the system to the specifications. The test shall be performed by the system supplier and witnessed by the City and the City Engineer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Shipments: The system supplier shall ship the equipment, materials, and accessories f.o.b. the plant site by dedicated air-cushioned van or acceptable equal according to the system manufacturer's recommendations. When the shipments arrive at their destination, the shipments shall be received, unloaded, stored, field erected and installed by the Company. Receiving, unloading, and storage shall not be construed as an acceptance of the work.
- B. Protection:
 - 1. Equipment shall be boxed, crated, or otherwise suitably protected during shipment, handling and storage.
 - 2. Coated surfaces shall be protected against impact, abrasion, discoloration, and other damages. The system supplier shall repair surfaces that are damaged.

3. Electrical equipment, controls, and insulation shall be protected against moisture and water damage. Environmentally controlled storage shall be provided for equipment as recommended by the manufacturer.
4. The system manufacturers' field representative shall return reusable containers and special shipping devices at system supplier expense.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:

1. Equipment furnished hereunder shall be designed and selected to operate without degradation in performance throughout the environmental extremes specified herein. Equipment shall be designed to prevent the generation of electromagnetic and radio frequency interference and shall comply with FCC Rules and Regulations, Part 15, for Class A computing devices.
2. Control room equipment shall be suitable for operation in ambient temperatures from 10 to 40°C and a relative humidity of 0 to 90 percent, non-condensing. Remote input/output hardware shall be suitable for an ambient temperature range of -10 to 50°C and a relative humidity of 0 to 95 percent non-condensing. Electronic equipment installed in Local or Unit Control Panels mounted in direct sunlight shall have the necessary temperature control devices to maintain temperature ranges recommended by the manufacturers. The lowest device rating installed shall determine the entire system rating.
3. System equipment will be installed in areas without anti-static floor construction and without any provisions for particulate or corrosive gas control other than normal office-type HVAC filtering. The supplier shall furnish any additional air cleaning equipment, anti-static chair pads, grounding straps or any ancillary equipment he deems necessary for proper operation of the system and to preclude destructive effects on this equipment.

B. Power Supply:

1. Unless otherwise specified, power supply to equipment will be 120 volts, 60 Hz, single phase and shall be conditioned by Uninterruptible Power Supplies sized for 20% expansion.
2. Electrical and electronic equipment furnished hereunder shall meet surge withstand capability tests as defined in ANSI without damage to the equipment.

1.08 WARRANTY

- A. The system supplier warrants that the work herein contracted will be as specified and will be free from defects in design, workmanship, programming and materials. Prior to final acceptance or if within the warranty period the work fails to meet the provisions of this warranty, the system supplier shall promptly correct any defects. Defects include nonconformity with the contract documents as defined by the City Engineer. Correct defects by adjustment, re-programming, repair, or replacement of defective logic, parts or materials.
- B. The system warranty period shall begin on the date of final acceptance and shall end eighteen months later.
- C. The system supplier shall furnish Field services, without cost, for the correction of any warranty defects.

- D. This warranty shall be extended to cover repairs and replacements furnished under the warranty and the period of the warranty for each such repair or replacement shall be eighteen months after installation or completion of each repair.
- E. Prior to final acceptance and/or during the warranty period, the system supplier will be given an opportunity to confirm the existence of reported defects but he shall not delay the correction while making such determination.
- F. Prior to final acceptance and/or during the warranty period: If within three (3) days after the City or the City Engineer has notified the system supplier in writing of a defect, failure, or abnormality in the work, the system supplier has not arrived and started to make the necessary repairs or adjustments, the City or the City Engineer shall make the repairs or adjustments or shall order the work to be done by a third party, the cost of the work to be paid by the contractor or by the Surety.
- G. Prior to final acceptance and/or during the warranty period; An emergency, where the supplier has been notified of a failure, and the Integrator expressed the inability to respond immediately. If (in the judgment of the City) a supplier projected time delay of the repair would cause serious loss or damage, repairs or adjustments may be made by the City or a third party chosen by the City. Work may commence without further notice to the system supplier and the cost of the work shall be paid by the contractor or by the Surety.

1.09 MAINTENANCE

- A. Spare Parts: Spare parts shall include, as a minimum, the following:
 - 1. Twenty percent or a minimum of one (1) spare module of each type used in the system including CPUs, adapters, bridges, repeaters, I/O modules, converters, power supplies, floppy drives, hard drives and Communications cards. ie. One through five components will require one spare, six through ten components will require two spares, ten through 15, three.
 - 2. One (1) spare of each type used of special termination, communications and interconnecting cables.
- B. During Construction
 - 1. Spare parts and supplies shall not be consumed during installation, debugging, start-up or training operations and shall be available in the quantities specified at the time of final acceptance. The system supplier shall provide replacement for supplies partially or totally consumed prior to final acceptance of the systems.
 - 2. In addition, the system supplier shall furnish any other spare parts or supplies that are recommended by the equipment manufacturer to maintain system availability at the level specified.
 - 3. Preventive maintenance must be performed by the system supplier in accordance with the manufacturer's recommended schedule during pre-acceptance operations.
- C. Supplies: Provide, as a minimum, the following supplies:
 - 1. One hundred percent spares for lamps and fuses.
 - 2. One field instrument of each type.
 - 3. One isolator of each type.
 - 4. Six Lamp extractors
 - 5. Two Fuse pullers

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Hardware. All the required hardware required for the control panel shall be provided by the systems integrator.

2.02 PERFORMANCE AND DESIGN AND CONSTRUCTION REQUIREMENTS

- A. General: The drawings and specifications that follow indicate the extent and general arrangement of the system. If any departures from the drawings or specifications are deemed necessary by the system supplier, details of such departures and the reasons shall be submitted to the City Engineer for review with or before the first stage submittal. No such departures shall be made without prior written approval. The system supplier shall be responsible for any design changes or charges attributable to any such departures.

- B. The System integrator shall confirm instrumentation is calibrated correct, functional and any and all hardware and software interlocks display and are correctly wired and programmed ensuring an operating system. The System Integrator shall submit the applications required for this project for approval to the City Engineer for structure and notation. The City Engineer's approval does not relieve the System Integrator from the obligation to provide a complete and working system as a requirement of this contract. The System Integrator is still responsible for the functionality of the applications.

1. Standard Products:

- a. Systems furnished under this section shall be essentially a standard product of the system supplier. Where two or more units of the same type of equipment are required, they shall be the products of the same manufacturer. However, components of the systems furnished hereunder need not be the products of one (1) manufacturer unless specified herein.
- b. This specification describes the minimum requirements for hardware and software. Where the system supplier's standard configuration includes additional items of equipment or software features not specifically described herein, they shall be furnished as a part of the system.

2. System Design:

- a. Design shall comply in concept with the System Architecture as shown on the drawings.
- b. The design of the systems furnished hereunder shall utilize concepts, techniques and features, which provide maximum reliability and ease of maintenance and repair. Diagnostic software shall be furnished to aid in troubleshooting at each system level.

- 3. Factory Assembly: Equipment shall be shipped completely factory assembled, except where the physical size, arrangement, or configuration of the equipment, or shipping and handling limitations make the shipment of completely assembled units impracticable.

4. Power Supplies:

- a. The system supplier shall be responsible for distribution of power between enclosures, consoles, peripherals, and other components of the system from the receptacles and junction boxes indicated on the drawings. Power distribution hardware shall include two (2) Uninterruptible Power Supplies (UPS), cables and branch circuit over current protection installed in accordance with Division 16. Surge and lightning protection shall be provided for each in accordance with Divisions 13 and 16. UPS shall be as

manufactured by Powerware 9170 with relay status card, 3kVA, or equal, w/ 2 extended battery bank extensions. The Uninterruptible Power Supply shall accommodate the entire panel. Company shall submit to the City Engineer all UPS loads prior to installation.

- b. Power supplies to obtain voltages required by the system supplier's equipment other than those provided above shall be an integral part of the equipment furnished. Internal power supplies shall be regulated, current limiting, and self-protected. Fusing shall be provided with "Blown-Fuse-Indicators".
- B. A system engineering analysis shall be submitted to the City Engineer indicating the calculations used in sizing equipment. The analysis shall indicate how the proposed equipment will operate as a "system" to meet the required performance specifications. Include communication through-put with present I/O population. Also, compute performance with proposed population expansion plus spares of 50% on all Analog and Discrete Inputs and Outputs I/O Points fully wired to/thru surge protection to terminal strip thus future field terminations require minimum amount of terminations. An excel spreadsheet shall be developed and submitted for approval by City Engineer depicting key fields indicating tag name, tag description, ranges, engineering units, set points, Rack, slot, address, terminal bridge number

2.03 PROGRAMMABLE LOGIC CONTROLLERS (PLC'S)

A. General:

- 1. Interchangeability: PLC/RTU systems provided by vendor or Systems Integrator shall be of the same manufacturer and same series of product line based on Modicon Quantum Series products. Input and output modules shall be interchangeable between the systems. Coordination of vendor supplied systems shall be by the Systems Integrator.
- 2. Communication Capabilities: The PLC will support communications with Modbus Plus, S908, Modbus RTU, Profibus DP V1 protocol, and 10BASE-T/100BASE-TX Modbus TCP communication.
- 3. Spare and Future Capacity:
 - a. Each PLC/RTU shall have provisions for future expansion and shall have 50 percent spare memory capacity installed. The spare capacity of the system shall be documented by submitting to the City Engineer, during factory testing, a statement indicating the amounts of memory being utilized and the total amount available in each system.
 - b. Each PLC/RTU control panel shall be provided with 50 percent spare inputs and outputs of each type used in the enclosure. The spares for that system enclosure shall be marked for identification as such. All I/O will be fully wired to the terminal bridge including surge protection and isolators.
- 3. A 12 Ft programming cable will be provided for each PLC.
 - a. Provide a licensed copy of the latest version of the PLC programming software.
 - b. Provide a Industrial Ethernet switch

A. Processor shall have the following specifications.

- 1. Front panel shall include a 2-line 16 character LCD display, backup battery access, restart pushbutton, 2-RJ45 connectors, type B female USB programming port, 9 way female SUB-D connector, and 2 PCMCIA slots.

2. Ethernet TCP/IP Modbus TCP messaging and I/O scanning up to 128 stations, automatic IP address assignment, 10BASE-T/100BASE-TX (RJ45), Data Rate 10/100 Mbps with automatic recognition, twisted pair.
 3. Quantum processor: Up to 26 local discrete slots, 31,744 decentralized. 26 local analog slots, 1984 decentralized, 6 local communication modules, 7.161 MB program memory, 1024 Kb data capacity, 266 MHz processor clock frequency.
 4. Conforms to UL508, cUL, CSA22.2-142, FM class 2 Div 2, CE
 5. Manufacturer/Model: Modicon Quantum/140 CPU 652 60 or pre-approved equal
- B. Discrete Input modules shall have the following specifications:
1. Discrete input modules shall have 16, 79 – 132 VAC, 47 - 63 Hz, minimum 4.9 ms and 7.9 ms for off-on and on off cycle respectively.
 2. Conforms to UL508, cUL, CSA22.2-142, FM class 2 Div 2, CE
- C. Discrete Output Modules shall have the following specifications:
1. Discrete output modules shall have 16 type A normally open contacts, 250 VAC nominal voltage.
 2. Conforms to UL508, cUL, CSA22.2-142, FM class 2 Div 2, CE
- D. Analog Input Module shall have the following specifications:
1. Analog input module shall have 8 channels, 12 bit resolution, $\pm 0.1\%$ absolute accuracy.
 2. Conforms to UL508, cUL, CSA22.2-142, FM class 2 Div 2, CE
- E. Analog output module shall have the following specifications:
1. Analog output module shall have 4 channels, 12 bit resolution, $\pm 0.2\%$ absolute accuracy.
 2. Conforms to UL508, cUL, CSA22.2-142, FM class 2 Div 2, CE
- F. Human Machine Interface Terminals shall have the following specifications:
1. Shall have a 15" liquid crystal display for process control graphics and alarm display.
 2. Bus and Networks: Ethernet, IEEE 802.3 10/100 BASE-T, RJ45
 3. 24 DC power supply.
 4. Manufacturer/Model: Magelis/XBTGT7340 or pre-approved equal

2.04 REMOTE I/O(RIO) AND DISTRIBUTED I/O (DIO) SYSTEM

- A. Interchangeability: PLC/RTU systems provided by vendor or Systems Integrator shall be of the same manufacturer and same series of product line based on Modicon Quantum Series products. Input and output modules shall be interchangeable between the systems. Coordination of vendor supplied systems shall be by the Systems Integrator.
- B. Spare and Future Capacity:
1. Each RIO/DIO rack shall have provisions for future expansion and shall have 50 percent spare memory capacity installed. The spare capacity of the system shall be documented by submitting to the City Engineer, during factory testing, a statement indicating the amounts of memory being utilized and the total amount available in each system.
 2. Each RIO/DIO rack shall be provided with 50 percent spare inputs and outputs of each type used in the enclosure. The spares for that system enclosure shall be marked for identification as such. All I/O will be fully wired to the terminal bridge including surge protection and isolators.

2.05 SCADA SYSTEM SERVERS

The following describes the minimum requirements for the hardware. The Company shall coordinate with VTS SCADA to provide all necessary hardware for the VTS SCADA system to meet VTS SCADA performance requirements in achieving a complete working system as described in drawings and specifications.

A. Real Time / Historical Server Equipment

1. Minimum processor operating speed: Dual micro processors shall be Intel® Xeon® X5560, 2.8GHz/84M Cache, 6.40 GT/s QPI, Turbo, HT. 2nd processor, Intel® Xeon® X5560, 2.8GHz/84M Cache, 6.40 GT/s QPI, Turbo, HT, or equivalent.
2. Ram memory shall be 8GB (4x2GB), 1066MHZ, Dual Ranked DIMM'S for 2 Processors, Adv ECC, or equivalent.
3. Shall have redundant power supply with straight cords, No Y cables are allowed.
4. Real time clock accurate to within plus or minus one minute per month.
5. No Keyboard Option; 2 NIC Intel Pro 1000MT Dual Port Cooper Gigabit PCI-e NIC 1 serial port; 1 RAID controller PERC 6/I SAS, PCIe, x8 Backplane.
6. Mirrored hard disks with a minimum of 200GB, 3Gbps, SAS, 3.5 inch, 15K RPM shall be provided. One pair shall be for each database.
7. Shall have 1 PERC 6/I, PCIe, x8 Backplane, Integrated, for the purpose of mirroring the 2 internal system hard disks.
8. 8X CD/DVD RW Drive: 1 1.44MB, 3.5 in, Floppy Drive
9. Embedded Management: iDRAC6 Enterprise

B. Domain Controller Equipment

The following describes the minimum requirements for the hardware. The Company shall coordinate with Telvent to provide all necessary hardware for the Telvent SCADA system to meet Telvent's performance requirements in achieving a complete working system as described in drawings and specifications.

1. Minimum processor operating speed: micro processor shall be Intel® Xeon® X5560, 2.8GHz/84M Cache, 6.40 GT/s QPI, Turbo, HT,, or equivalent
2. RAM memory shall be 8GB Memory (4x2GB), 1066MHZ (4X1GB), Dual Ranked UDIMM'S for 1 processor, Adv ECC, or equivalent.
3. NIC Intel Pro 1000MT Dual Port Cooper Gigabit PCI-e NIC 1 serial port; 1 RAID controller PERC 6/I SAS, PCIe, x8 Backplane, Integrated.
4. Hard disks with a minimum of 2 73GB, 3Gbps, SAS, 3.5 inch, 15K RPM shall be provided.
5. 1 8X DVDROM
6. Embedded Management: iDRAC6 Enterprise

C. RAID Storage

The following describes the minimum requirements for the hardware.

1. 1 Rack Mount Chassis, 14 HDD, SCSI Storage Enclosure shall be included, or equivalent.
2. 7 X 73GB 15K U 320 SCSI Hard Drive shall be included.
3. 1 Enclosure Management Module hard drive controller, or equivalent shall be included.
4. The disks within the storage enclosure shall be mirrored in 2 disk mirror sets. The mirroring shall be done with hardware controllers, and each mirror set (1 pair of 2 mirrored disks) shall be presented to the host computer as 1 virtual disk. Under this configuration, 7 virtual disks shall

shall be available for read / write access to both RTS/HIS SCADA host computers. Within a HOT/STANDBY server configuration, only the server running the HOT Historical service will read / write from shared disks.

D. Operator Workstations

The following describes the minimum requirements for the hardware.

1. Two-22 -inch LCD display screens.
2. 256MB ATI Radeon 3470 Dual Monitor (2 Display Ports and/or 2 DVI).
3. 2 GB Non-ECC Dual Channel 800MHz DDR2 SDRAM
4. One (1) 3.5" 10K RPM SATA II 160 GB
5. Dual Drives: 48x CD-RW Drive + 16x DVD+RW/+R w/ double layer write
6. One (1) integrated 10/100/1000 Ethernet (Intel WG82567LM LOM).
7. One (1) 1.44MB 3.5 inch Floppy drive
8. One (1) USB 2-button optical mouse with scroll.
9. One (1) USB keyboard.
10. Five year on-site extended warranty.
11. Install Licenses of VTS SCADA development software
12. Two (2) color printers shall be provided. Provide dual-cartridge inkjet printer with 1200 dpi resolution rated 6 ppm b&w, 2 ppm color. Provide all connectors and cables (lengths as needed). Color inkjet printers shall be Hewlett Packard HP Color Inkjet cp1700d printer with Ethernet connection. Provide paper for system and plant operational testing, estimated to be two boxes of plain 11x17 paper (3000/box), and two boxes of 8½x11, 20lb white bond paper (5000/box).

E. LAN System

1. All network equipment to be supplied will support the TCP/IP protocol using 10/100/1000BaseT Ethernet technology running up to 100/1000 Mbps, as well as Advanced VLAN support.
2. Communications will be through Ethernet switches and a router. Ethernet switch shall be CISCO 3750G-24PS or latest including fiber optic switch modules as required. provide 50% spare.
3. Juniper SSG series firewall router for routing and firewall protection shall be supplied. The unit shall be supplied with all cabling, hardware and software required for the application.
4. Cisco Catalyst 3750G-24PS Switches shall be supplied. Network Switches: Network switches shall provide communication between network devices using network cables. Network switches shall be a minimum of 24 ports. Each port shall have LED indicator for network monitoring status. Network switches shall permit online network changes without disturbing network devices. Malfunctioning network devices shall be automatically removed from service without shutting down the network. Ethernet switches shall be furnished with high speed fiber optic ports as required and 50% spare for network connections.
5. SONET Multiplexer shall be a DDM-2000 OC-3 by Lucent technologies. The SONET multiplexer shall be connected to receive all optical I/O cables and connected the Ethernet net switches via the Juniper firewall unit.

F. Uninterruptable Power Supply (UPS)

1. Uninterruptible Power Supply (UPS). The main 8,000kW Uninterruptible Power Supply shall provide power conditioning for the main control workstations main station control panels, including peripherals, operators HMI, Programmable Logic Controller and associated remote input/output within the control room and the IT room. Each I/O enclosure, main station control panel shall contain its own local UPS. The local UPSs shall have sufficient capacity so as to provide complete full operational capability for at least 15 minutes upon loss of main power. The UPSs shall be powered by a single phase 120V input and shall provide up to four 15A receptacle outputs. The UPSs shall be free standing and shall furnish a low battery alarm to the PLC system for monitoring. The UPSs shall be Powerware model Ferrups or approve equal.

2.06 SOFTWARE AND PROGRAMMING

- A. These Specifications are intended to give a general description of what is required, but do not cover all details which will vary in accordance with the requirements of the equipment furnished. They are, however, intended to cover the furnishing, the delivery and complete installation and field testing, of all software and programming for complete systems herein specified, whether specifically mentioned in the Specification or not.
- B. No programming, compiling or linking shall be required to configure the HMI graphical software following initial installation of the software on the computer system. The system shall be configurable on-line such that new function blocks and data base assignments can be added while the system is simultaneously performing data acquisition and control operations.
- C. The HMI system software and VTS SCADA system shall support a user-based security system. If enabled, the security system must allow for the creation of users with certain rights and/or privileges. These rights shall include the ability to run any combination of, or all of the applications in the data acquisition system. The security system shall support either centralized or distributed security file management. When user-based security is enabled, an audit trail shall be generated in the system which will tag every operator action with user identification (ID).
- D. The HMI system software and VTS SCADA system shall be configured such that the failure of any one computer will not affect the operation of others on the network. It is recognized that data contained in a failed machine will be unavailable to other machines requesting it. However, the system shall offer the provision for re-starting or re-configuring other stations to take over, especially in the case where a failed machine is being used for graphic display.

2.07 SYSTEM DATABASE

- A. The Company shall develop and assign identification tag names to all I/O points in the PLC database, local HMI and Telvent SCADA system. All Tag names shall conform to the Government's standards and preferences for the identification of discrete and analog I/O. The software programmer shall meet with the Government prior to any programming activities to coordinate tag naming conventions for each individual tag. An initial release of the database is required within 2 weeks after the coordination meeting. The PLC database, HMI database and Telvent SCADA database tag names shall be the same to greatest extent possible, subject to individual software semantic limitations. As a minimum, each database shall have the following:
 1. Tag identification number.
 2. Tag description.

3. Rack/Slot/Point assignment.
4. Internal PLC I/O address.
5. Analog low and high scale values and engineering units.
6. Analog low-low, low, high, high-high alarm limits.
7. Digital on/off descriptions.
8. Digital alarm state.
9. Additional interface address (if necessary)

2.08 VTS SUPERVISORY, CONTROL, AND DATA ACQUISITION (SCADA) SYSTEM

- A. The control room SCADA HMI system software for operator workstations and servers shall be VTS SCADA, latest edition, no exceptions.
- B. The Company shall furnish, test, install and place in satisfactory operation all VTS SCADA system software with all required programming and software appurtenances as herein specified and as shown on the Drawings. The Company shall coordinate with VTS for all software modules, licenses, drivers and appurtenances necessary for a complete working system in place. If VTS requires additional software, hardware, programming or appurtenances in addition to those specified in the contract documents, the Company shall furnish those items at no additional expense.
- C. The VTS SCADA system software shall provide all control and monitoring capabilities necessary to support all operations and functions, plus a minimum expansion of 50 percent of the current number of points, complete with their point database.
- D. The operating system software shall be latest version of Windows XP or Vista Workstation that is recommended by VTS at the time of installation or substantial completion.
- E. System parameters such as: date, time, set points, alarm limits, loop tuning constants, etc., shall be enterable or modifiable via the operator's workstation. Data validation shall be performed on operator inputs to reject illegal entries, and any input which modifies the system shall be printed on the associated logging printer together with the date.
- F. The system shall automatically compensate and convert system data for Leap Year, Daylight Saving, and Standard time clock changes.
- G. Licenses for VTS development and PLC programming software shall be supplied.
- H. The System Shall have the following
 1. Alarm records, lists, and reports.
 2. Historical Data Logging of all analog inputs.
 3. Graphic Display Editing
 4. Daily, Weekly, and Monthly average reports.
 5. Trending for all analog inputs.
 6. SQL Server
 7. PLC Drivers
 8. PLC programming software

9. Microsoft office professional latest version.

2.09 ALARMS

- A. Alarming: Unacknowledged alarm messages shall appear in a high priority window designed to appear at each active console at all times. All active alarms shall also appear in a tabular alarm summary. Alarms shall also appear on appropriate schematics and tabular point summaries. The concept of a group or station alarm shall be supported by the system. It shall be possible for each station to have devices contained within it, and when these devices are in alarm, the station to which it belongs shall be notified. A controller shall be able to access these alarms by clicking the station on the geographic or schematic display, causing a station alarm summary to appear. Station alarm summaries shall behave in the same manner as the system alarm summary, and shall contain a severity and time-ordered list of all the alarm messages for all the devices within that station. Real-Time Services shall generate alarms and events from telemetered and calculated point data, as well as from application programs within the alarming subsystem. These alarm records shall be maintained online for a user-specified period of time, then archived offline. The system shall also offer disturbance mode and alarm suppression functionality. It shall be possible to operate in Disturbance mode, where low priority alarms are not processed. Hierarchical alarm suppression shall prevent large numbers of alarms from cluttering a controller's display when they are triggered as the result of a single device going into alarm. This suppression shall apply to parent and child device relationships only. It shall not extend to other "offspring" devices.
- B. Alarm Severity: The severity of generated alarms shall be configurable for all alarm generating points or devices. Severity of an alarm message shall be configurable to be one of three levels of severity (high, medium or low). Alarm severity shall be distinguishable by a configurable color scheme, audible signal and relative placement in the tabular alarms displays.
- C. Alarm Annunciation: Audible Alarms shall be configurable to be a beep pattern or a "wav" file. Inhibiting alarm annunciation shall be possible for each operational console. Inhibiting alarming shall inhibit only the currently annunciating alarms. Any alarms arriving at the console subsequent to inhibiting annunciation shall not be subject to the prior action, but shall annunciate to indicate the arrival of a new alarm.
- D. Alarm Message: The alarm message shall appear in the alarm window and in the tabular summary of alarms. The alarm message shall include the time and date of the alarm, the point that caused the alarm, the severity of the alarm (via color and audible signal) and the state of the point.
- E. Alarm Acknowledging: Alarms shall be acknowledgeable by use of the cursor control device via the appropriate selection of an active area in the Alarms window, the tabular alarm summary or the control window for the appropriate point. Alarms shall also be acknowledgeable via a PAGE ACKNOWLEDGE button on the tabular alarm summary. Only alarms in view on the displayed page shall be acknowledgeable. Acknowledging an alarm shall also silence the audible alarm. It shall not be possible for the system to automatically acknowledge alarms.
- F. The system shall synchronize each SCADA station computer, real time clock, within 1 minute and at least once per day automatically, without operator intervention and without requiring system shutdown.
- G. Under system normal heavy load, no more than 1.5 seconds shall lapse from the time a digital status alarm or analog alarm occurs at a PLC until the change is displayed at the SCADA system and operator's workstation. The total system response time from initiation of a control action command

command to display of the resulting status change shall not exceed 1 second under system normal heavy load conditions, assuming a zero response time for operation of the PLC's control device. All system normal heavy load conditions shall be introduced to the system via AI'S and DI'S.

2.10 REPORTS

- A. Report Generator: Software shall be provided to generate and format standard and custom reports for displaying, printing, and storing on disk. Reports shall use database values and parameters, values calculated using the real time database or historical data base; with the reports subsequently stored on hard disk. Dynamic operation of the system shall not be interrupted to generate a report. The report shall contain the time and date when the sample was taken, and the time and date when the report was printed.
- B. The system shall allow for specifying, modifying, or inhibiting the report to be generated, the time the initial report is to be generated, the time interval between reports, end of period, and the output peripheral.
- C. Request Report Mode: The system shall allow for the operator to request, at any time, an immediate printout of any report.
- D. The Company shall program the following reports to be displayed on the screen and printed at the request of the Operator:
 - 1. Weekly Run time report of all equipment.
 - 2. Weekly Fuel usage report based on Day tank levels.
 - 3. Weekly Plant operations report showing the total volume of water that was pumped.
 - 4. Trends for all of the Analog inputs.
 - 5. Daily, Weekly, and Monthly average flows and flow totals.

2.11 HISTORICAL DATABASE

- A. The SCADA system shall provide extensive historical data storage and retrieval capabilities. History shall derive from real-time, calculated, controller-entered and RTU files. The Historical Services shall provide for the long-term storage of Real-Time measurement, event, alarming and other pertinent data monitored or generated by the SCADA system.
- B. Instantaneous data shall be available to be transferred and saved from the real-time database to the Historical Data Subsystem. It shall be possible to summarize instantaneous data to generate hourly, daily, monthly and yearly values. The summarized values shall reside in the Historical Data Subsystem. The SCADA system shall have live access to the historical data for use in reports and on displays. The historical database size shall only be limited by the physical capacity of the storage media available.
- C. On-Line Historical Data: On-line historical data shall be accessible to controllers for reports, queries, analysis, display, and trending. It shall be possible to save the following data types as on-line historical data:
 - 1. Status point values
 - 2. Analog point values
 - 3. Rate point accumulator values or rate point flow-rate values
 - 4. Hourly and daily volumes

5. Alarms
 6. Events
 7. Messages
 8. Communication statistics for host to field devices
- D. Historical data shall be collectable on a periodic basis with a minimum resolution of one minute. It shall be possible to configure historical data collection to occur by exception when a value changes by more than a user-defined dead-band amount. Data stored by exception shall be recorded at least once per hour whether it has changed or not. All data, whether acquired or calculated by the system, shall be eligible for historical data storage.
- E. The SCADA system shall have a mechanism for automatically archiving historical data, onto offline storage media, that has aged beyond a user-configurable period. This data is no longer required to be kept on-line in the historical database. The data shall archive to a Write Once, Read Many (WORM) optical storage device, after which the system administrator shall easily purge (or automate the purging) all archived on-line historical data to make room for new data. The Historical Data Subsystem shall allow for different on-line and off-line archiving of data. For example, the system shall allow for events to be kept on-line for a different period than the communications statistics.
- F. The archiving function shall ensure that the correct media is loaded in the archive WORM drive prior to transferring any data. The historical archiving system shall keep a catalog of the data that has been archived in conjunction to the media that the data is stored in. This catalog shall be used by the system to locate the appropriate archive media when de-archiving into the system. A "clean-up" utility shall be available to remove de-archived data from the system. The "clean-up" utility shall be executed manually after the user completes any queries or reports that make use of the de-archived data.
- G. Occasionally, it may be necessary to edit certain historical data in order to correct errors or omissions caused by upset conditions. The system shall provide a facility to edit this data. It shall be possible for appropriately authorized personnel to edit the on-line historical database and manually overwrite questionable or missing data.
- H. A hardware mirroring option shall be utilized to mirror all historical databases onto on-line disks available to the SCADA system. All historical databases on disks shall be mirrored, so that a failure of a disk shall not cause a failure of a particular historical database. When a disk fails, the mirrored disk shall have the same copy of data as the master disk. This disk shall make available to the system the historical data for the failed disk. The primary historical system shall always know the state of the other system. A historical system in a standby state shall always be ready to go to a hot state. The size of the disks shall allowed minimum six (6) month of herein defined historical data to be stored.

2.12 FABRICATION AND MANUFACTURE

A. General:

1. Device Identification:

- a. Devices mounted on or within the enclosures shall be permanently identified. The device and terminal identifications shall agree with those indicated on the equipment drawings.

- b. Nameplates shall be provided on the face of the panel and on the individual devices as required. Panel nameplates shall have legends indicating the identity of the panel and shall be approximately 1.5 inches high by 6 inches long. Nameplates shall be made of laminated material having engraved letters extending through the black face into the white layer. Nameplates shall be secured firmly to the panels and devices by two-part epoxy and stainless steel screws.
2. Shop Painting:
- a. Suitable coatings applied in the shop shall protect metallic surfaces subject to corrosion. Surfaces, which will be inaccessible after assembly, shall be protected for the life of the equipment. The surfaces shall be cleaned and prepared in the shop. Mill scale, rust, lubricants, and other coatings shall be removed. Exposed surfaces shall be finished smooth, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Surfaces shall be treated to resist rust and to form a bond between the metal and the paint.
 - b. The enclosures shall be given one or more coats of rust-inhibiting primer and two coats of high grade oil-resistant enamel, lacquer, or polyurethane finish both inside and out. Paint applications that show sags, checks, blisters, teardrops, or fat edges will not be acceptable. Any such defects shall be repaired by and at the expense of the system supplier.
 - c. The system supplier shall include touch-up paint with equipment furnished. Touch-up paint shall be of the same type and color as the factory applied finish paint. One (1) gallon of finish color shall be furnished for future touch-up. Complete application instructions shall be furnished. The paint and instructions shall be boxed or crated to prevent damage, and shall be clearly labeled.
 - d. The interior finish colors of the master station enclosures shall be the system supplier's standard colors while the exterior color shall be selected by the City. Provide paint chips during shop drawing submittals for selection.
 - e. Unit Control Panels shall be brushed stainless steel exteriors with white painted interiors.

B. Operator's Console:

Though specified in this section, the City will contract for this item after the bid or elect to build the console utilizing City personnel.

- 1. The operator's console shall be of adequate strength to support the mounted equipment and a concentrated load of 300 pounds per square foot on the top surface without damage or deformation. The desk area edges shall be curved and soft to prevent injury to operating personnel.
- 2. Exterior surfaces and edges shall be smooth and blemish-free. No weld marks or other blemishes shall be visible. The top and side surfaces shall be free of bows, waves, dimples, or other imperfections.
- 3. The equipment shall be arranged as indicated on the drawings. The equipment shall be removable for maintenance and replacement without dismantling the console. Both the CPUs and UPS shall be mounted on pull out shelves. Space shall be allotted on the console for the CCTV security camera monitoring equipment and gate controls as applicable.
- 4. The console shall have at least 10 square feet of free and contiguous work surface in addition to the space required for equipment. The desk area in front or to the right of each keyboard (i.e.,

(i.e., between the edge of the console and the keyboard) shall have at least 12 inches of space for a writing area. Front and rear access doors with flush mounted hardware shall be provided.

5. The console shall be designed to provide air circulation that shall sufficiently cool the CRTs and internally mounted electronic devices.
6. The final arrangement of the console and its color shall be approved by both the City and the City Engineer. Provide paint chips during shop drawing submittals for selection.

2.13 AUTOMATIC GATE OPENER AND ENTRY SYSTEM

A. General. The electric slide gates shall be designed for moderate industrial application. The system will utilize:

1. Continuous duty PSC motor
2. 24 Volt control circuit
3. Electrical Power Disconnect
4. Three button control (Open-Close-Stop)
5. Clutch timer protection
6. Delay on reversal
7. Warning Beeper
8. Double v-belt drive
9. Heavy duty steel, weather resistant, all welded enclosure
10. Gasketed Hinged lockable cabinet
11. Pad Mounted
12. Adjustable rotary limit switches
13. Manual Disconnect
14. Adjustable double sided friction clutch
15. Heavy duty pillow block bearings
16. No. 40 Roller chain drive
17. Signal light, Red (gate moving) strobe or steady

B. Gate Operator Controls

1. Provide a complete two station intercom system with keypad
2. Single line telephone call system accessible from the keypad
3. Heavy duty 42" gooseneck stands (pad-mounted)
4. Gate and gate operators shall be as manufactured by OSCO or equal.

2.11 Remote Telemetry Units

Remote telemetry units shall be provided for the plant and production wells to communicate with the City's existing SCADA infrastructure. The City currently uses Motorola MOSCAD system utilizing an 800 MHz trunk. No substitutions are acceptable. Coordinate the latest part numbers and RTU design with the City.

PART 3 - EXECUTION

3.01 INSPECTION

- A. The equipment furnished under this section shall be subject to inspection by the City during the factory acceptance tests herein specified. Additionally, the Company and Systems Integrator shall visually inspect each piece of equipment for damage when it is uncrated on-site.
- B. Damaged or inoperative equipment shall not be installed.

3.02 INSTALLATION

- A. The installation of the equipment shall be in accordance with the drawings and specifications, equipment manufacturer's recommendations and the applicable codes. RTUs shall be bolted in place and grounded to the instrument grounding bus.
- B. Field Wiring: Field wiring materials and installation shall be done in accordance with Section 13, and Section 16050: Electrical.

3.03 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: The services of the system supplier's technical representative shall be provided as necessary to calibrate, test, and advise others of the proper installation, procedures for adjustment and operation in accordance with Section 01600: Material and Equipment.
- B. Systems Check:
 - 1. The system supplier shall provide at least 90 working days of system start-up assistance by factory-trained engineering and programming personnel. During this start-up period, these personnel shall thoroughly check equipment, correct deficiencies, and repeat the factory testing procedures described herein.
 - 2. If interrelated devices furnished by other suppliers or under other contracts (such as valve operators, motor controls, chemical feeders, and instruments) do not perform properly at the time of system checkout:
 - 3. The System Integrators technical representative shall use suitable test equipment as may be required to locate the source of trouble or malfunction. A written report regarding the results of such tests shall be furnished as necessary to the City Engineer to resolve any question of responsibility for corrective measures.
 - 4. System supplier shall provide additional on-site working days as required to coordinate and supervise termination and start-up of associated pumps, drives, and blowers. A minimum of 45 days is required.
- C. Installation Test Equipment: Test equipment, necessary for calibration and check of system components, shall be provided by the system supplier and reviewed by the City at acceptance for correct calibration. The system integrator shall perform all RTU/HMI programming. A list of proposed test equipment to be utilized on this project shall be submitted during the first submittal. Test equipment utilized for on-site calibration must have a current calibration sticker affixed and be approved by the City Engineer. Required tests performed with non-certified and/or unapproved equipment shall be rejected and must be performed again.

END OF SECTION

SECTION 13326
PANELS AND CONTROL ROOM HARDWARE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide control panel and control room hardware as indicated on the drawings and as specified herein.
- B. The requirements of Section 13320, as applicable, apply to this Section.
- C. Refer to Section 13321, 13322
- D. Refer to Section 16, General Electrical Requirements.
- E. Refer to Section 16, for starter requirements.

1.02 SUBMITTALS

The submittal shall be in accordance with Appendix 5 of the Service Contract, and Section 13320 as well as the description below.

- A. Manufacturer's data.
- B. Shop drawings for approval.
 - 1. Dimensional and structural.
 - 2. Interconnection diagrams.
 - 3. Loop diagrams.
 - 4. Electrical ladder drawings.
 - 5. Complete bill of material.
 - 6. A complete set of as-built panel schematic and layout diagrams shall be stored in a packet provided in each panel. Any changes incurred during installation and start-up shall be documented and an approved resubmittal made to replace the original set.
 - 7. Tubing diagram.
- C. Certificates of compliance.
- D. Certified test reports.
- E. Operation and maintenance manual. Refer to Division 1.

PART 2 - PRODUCTS

2.01 CONSTRUCTION

- A. Unit Control Panels and Local Control Panels shall be furnished completely pre-wired, with factory-mounted instrumentation, controls and factory-tested for proper operation prior to shipment.
1. Piping and Wiring. Within each panel, piping and wiring shall be grouped and supported to give a neat appearance. Control components not flush-mounted on the front of the panel shall be mounted on fully accessible sub-panels or racks within the panels for easy removal. Signal lines leaving the panels shall terminate at bulkhead fittings or surge protected terminal blocks and shall be tagged to facilitate field connections. Doors and the back-plates shall be bonded to the enclosure.
 2. Size and Supports. Panels shall be of sufficient size to adequately enclose instruments designated as panel-mounted plus ample interior clearance to allow for installation, general servicing, and maintenance of the instruments. The weight of installed instruments shall be supported by Unistrut, Famet, Caine, or equal channel supports, both at the front and rear, channels supported by framing to the panel base. Minimum nominal panel size shall be as indicated on the drawings.
 3. Openings. Provide doors in panels if specified or shown on the drawings to give access to panel interior. Provide a side or rear-opening door where instruments are mounted in the panel face unless otherwise noted. Provide full-length stainless steel piano hinges on doors sized to fully support the door and all door-mounted instrumentation and controls.
 4. Attachment methods shall be detailed on shop drawing submittals.
 5. Control Voltage. The control voltage provided is 120 VAC power, supplied from the instrument power panels supplied under division 16. A separate low-voltage circuit (24VAC or 24Vdc) shall be provided within the panel for the indicating lamps or individual transformer type lamps shall be provided. Indicating lamps shall be individual push-to-test lamps. The applied indicating lamp voltage shall not exceed 30 VAC or DC. Safety interlock switches, not shown in the schematics, shall be provided on access doors for local and foreign voltages as required by safety codes of applicable regulating authorities.
 6. Arrangement. Where so indicated, the instruments mounted in the panels shall have the nominal size and general arrangement shown. Panel layouts and nameplates shall conform to the approved shop drawings.
 7. Louvers. Shall be provided when required near the bottoms and tops on the rear doors and sides of panels. Eighty-mesh screens shall cover the insides of all louvers and easily serviceable filters shall be provided where circulating fans are utilized.
 8. All discrete monitoring points required by the Plant Instrumentation and Monitoring System shall be isolated dry contacts supplied to the customer connection terminal boards. All analog signals shall be "isolated", surge protected and supplied to the customer connection terminal board.
 9. Corrosion Inhibitors. All control panels shall include installed corrosion inhibitors sufficient to safeguard the equipment for one (1) year. Use only those emitters recommended by the equipment manufacturer. An additional one (1) year supply of replacement emitters shall be furnished to the City at commissioning.
 10. Heat Dissipation. All control panels shall be designed so as to preclude any potentially damaging over-heating problems. Enclosure heat input (devices), material of construction, environment, and cooling options shall be considered. All calculations shall be provided

accompanying the cut sheets for each proposed control panel during the first stage submittals. Include a separate tabbed insert for each panel and field mounted instrument detailing expected performance. List all rain or sun shielded instruments and control panels and the calculations used for sizing.

2.02 STEEL PANELS

- A. Control panels sheet steel shall be especially selected for smoothness and flatness. Panels shall be fully enclosed, including top, with no visible seams on the front. Panels with front mounted instruments shall have front construction of 3/16-inch-thickness with stiffener(s) as necessary to maintain a flatness of plus or minus 1/16 of any 2-foot span and plus or minus 1/8-inch over any 8-foot span with equipment installed. Other sections shall be 3/16-inch, except the doors shall be a minimum of 14-gauge and shall maintain the same specified flatness when closed and latched.
- B. Cabinets shall be freestanding with adequate internal bracing to support the weight of instruments and wiring. The cabinet design shall be for front, top and rear access only to the extent available in the space shown on the drawings. Connections to and from the cabinets shall be through conduit as indicated.
- C. Finish. After fabrication, welds shall be ground smooth, the panel shall be degreased, bonderized, finished smooth with an epoxy filler and sanded. Two coats of a rust-inhibitor primer shall be applied. The finish coat shall be as selected by the City Engineer from color chips submitted by the panel manufacturer. Provide color chips during shop drawing submittals. Damage to the finish during installation shall be touched up at the job site as approved. Provide one quart of touch-up paint for future use.

2.03 STAINLESS STEEL PANELS

- A. Stainless steel panels shall be made of 316 stainless steel and have a brushed polished finish on all exposed surfaces. Construction requirements are the same as for steel panels except painting is not required. Mounting brackets and hinges shall also be 316 S.S.

2.04 PANEL HARDWARE

- A. Doors shall be set flush with 3-point vault-type key-locking latches in addition to any required screw clamps. Hinges shall be full-length piano types. Hardware and handles shall be stainless steel.

2.05 PANEL ACCESSORIES

- A. Relays and other internally mounted equipment shall be of the types specified in Section 13321. Industrial relays shall be Allen-Bradley or equal.
- B. Panel face-mounted instrument equipment shall be of the types specified in Section 13321.
- C. Selector switches and pilot lights shall be oil-tight Allen-Bradley Series 800 or equal.
- D. Panels 36 inches high by 36 inches wide by 12 inches deep and larger shall be internally lighted by fluorescent lamps, provided with guards and a door switch. A duplex-grounded receptacle shall be provided in each panel section. The lights and receptacles shall be wired through circuit breaker(s) to outgoing terminal blocks for 115-volt, 60-Hertz, single-phase supply.

- E. Nameplates shall be white lamicoid with minimum 3/16-inch-high black letters for major area titles, 5/32-inch for component titles, and 1/8-inch for subtitles. Internal nameplates shall be fastened with a permanent but dissolvable adhesive. Exterior nameplates shall be fastened with stainless steel screws.
- F. Terminals Connections. Wiring terminations to screw terminals on equipment shall be connected by compression spade lugs. Signal terminations shall be at surge protected terminal blocks (such as Allen-Bradley's Model with gas-tube arrestors, Suppression diodes and metal oxide varistors).
- G. Wiring shall be enclosed in plastic wireways, neatly tied with plastic ties, as appropriate. Wiring shall be made with PVC-insulated stranded wire. Terminal blocks shall be sectional barrier type with tubular clamp and white plastic identification strip Allen-Bradley Bulletin 1492 or equal. Provide sufficient terminals for all required tie points and 20 percent spares. Each terminal shall be identified on the marker strip with a number neatly printed in ink. Where wires are terminated on screw terminals, insulated crimped spade lugs shall be used. Wires shall be color-coded with black for unswitched hot or power, red for switched hot or control, white for neutral, green for ground and blue for DC. Wire size shall be 16 AWG stranded, 600-volt insulation except where larger wire is required for a single load. Signal wiring (4-20 Ma) shall be twisted-pairs with shielding. Wiring shall have permanent markers at each end. Except as otherwise stated herein, Division 16 General Electrical Requirements shall apply.
- H. Wire markers shall be 720 degree wrap, vinyl cloth, Brady B500 or equal.
- I. Provide stainless steel instrument air tubing, dual supply manifolds including pressure reducing valves (with gauges) and all isolation valves to permit service of any component without shutdown of the air supply. Provide 3-valve manifold arrangement for each differential pressure instrument to permit testing/calibration.
- J. Provide lightning/surge protection per Section 16.
- K. Panels which contain either 120, 208, or 480 VAC and signal (instrument) cable shall have a 16 gauge sheet steel barrier, 3-3/4" deep (minimum) separating the signal wire from the AC wires.
- L. Strobe lights, enclosures, controls and alarm horns shall be provided at eyewash/shower stations, or as indicated. Strobe lights shall be Federal 371, 120 volt, or equal.
- M. Circuit breakers shall be by Square D, Siemens or Cutler Hammer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. In accordance with the manufacturer's instructions and the approved shop drawings.

END OF SECTION

SECTION 13820

COMMUNICATIONS

PART I - GENERAL

1.01 DESCRIPTION

- A. This Section outlines the electrical work for communication equipment installations and wiring installations.
- B. The Company shall furnish all equipment, accessories and material required for the installation of a comprehensive communication system in strict compliance with these specifications and applicable contract drawings. Any material and/or equipment necessary for the proper installation and operation of the system, which is not specified or described herein, shall be deemed part of this specification.
- C. Related Work Not Included in This Section.
 - 1. Earthwork, Division 2.
 - 2. Concrete, Division 3.
 - 3. Painting, Division 9.
- D. Power Supply. The power supply shall be alternating current, 60 hertz and 120 volts as shown on the drawings.
- E. Conduits and conductors shall be provided by the Electrical contractor as required for an operable system. Coordinate locations and interconnects with the Electrical contractor. Provide the Electrical contractor with required interconnect and installation information.

1.02 SUBMITTALS

- A. Submit for Contract Administrator and copy to City Engineer for City Engineers' approval material lists, shop drawings, factory test reports, manufacturer's certified reports and technical data to the extent required in this Section and Section 16010.
- B. Shop Drawings. In addition to the information required to be included in the shop drawings as specified in Section 16010, shop drawings shall include the following:
 - 1. Plans shall show the equipment and wiring layouts.
 - 2. Elevations shall show the equipment vertical positions and component arrangements, and nameplates.
 - 3. Details shall show the required enlarged views of small parts.
 - 4. Diagram shall include complete controls, wiring and terminals with numbers.
 - 5. Dimensions shall be included on the drawings.
 - 6. Weights for equipment shall be included on the drawings.
 - 7. Nameplate Data shall include the material description, heights of letters and inscriptions.

- C. Technical Data. Complete equipment descriptive, operation and installation data shall be submitted with the shop drawings.
- D. Test Reports. Copies of the equipment factory test reports shall be certified by the manufacturer and submitted to Contract Administrator and copy to City Engineer as outlined in Section 16010.
- E. Installation and Operation Reports. Copies of the Manufacturers Certified Reports for the equipment installations and operations, as specified in Section 16010, shall be submitted to the Contract Administrator and copy to City Engineer.

1.03 WARRANTY

- A. The Company shall warrant the equipment to be new and free from defects in material and workmanship, and will, within one year from the date of acceptance and at no charge, repair or replace any equipment found to be defective. This warranty shall not apply to any equipment which has been subject to misuse, abuse, negligence, accident, or unauthorized modification.

PART 2 - PRODUCTS

2.01 GENERAL

Provide all the equipment and materials, including proper space, and complete all the installations as shown on the drawings, specified and required. All outdoor equipment shall be weatherproof and gasketed.

2.02 TELEPHONE

- A. Provide the earthwork, concrete, manholes, handholes, pull boxes, terminal cabinets, wood backboards, outlets, conduits, fittings, pull wires, supports and grounding as indicated specified and required, and in accordance with the requirements of the telephone company.
- B. Telephone Company will provide the instruments, terminals, relays and cables, and complete the installations and connections.
- C. Pay the telephone company for all charges that are required for the complete installations.
- D. Telephone Cabinets shall be of sufficient size to accommodate all the required terminals and equipment. The cabinet shall have a plywood back panel, front trim, ground lug, hinged door, latch and lock with two keys, and painted as specified in Section 16010. Telephone cabinets shall be Square D, Circle A/W, Hoffman or equal.
- E. Backboards shall be 3/4 inch fir plywood of sufficient size to accommodate all the required terminals and equipment. The wood backboard shall be equipped with a ground lug, and shall be painted as specified in Division 9.
- F. Submittal for City Engineer's approval shall include shop drawings for telephone cabinets and backboards.

2.03 PLANT PAGING

- A. Provide all the required equipment installations and wiring installations to satisfactorily complete the plant paging system as specified and required.
- B. The communication system shall bear the label of a Nationally Recognized Testing Laboratory (NRTL) such as: E.T.L., D.S.&G., or U.L. and be listed by their re-examination service. All work must be completed in strict accordance with all applicable electrical codes, including N.E.C. section 800-51 (1), under direction of a qualified and factory approved distributor, to the approval of the City Engineer.
- C. The system is to be designed and configured for maximum ease of service and repair. All major components of the system shall be designed as a standard component of one manufacturer. The equipment shall be Gai-tronics or equal
- D. Any system and/or equipment proposed as an equal to that specified must be proven to conform to the standards contained herein. Approval of equipment other than that specified does not relieve the Company from the responsibility of modifying the equipment if necessary, to meet the functional, structural, architectural, electrical, or mechanical conditions as detailed.
- E. Upon request of the City Engineer, any system proposed as an equal shall be made available for demonstration. The demonstration shall be coordinated with the City Engineer and the City..
- F. The system shall be supplied by the manufacturer's authorized contractor who is qualified in the proper installation, operation, and service of the system. Certification shall be submitted verifying that the contractor is the manufacturer's authorized contractor. Certification that the dealer has successfully completed the submitted manufacturer's installation and service training classes shall be included in this submittal.
- G. Final approval of the alternate system shall be determined at the time of job completion. Failure to provide the "precise functional equivalent" shall result in the removal of the alternate system at the Company's expense.

2.01 COMPONENTS

- A. The system shall consist of a desk unit at the main reception area connected to speaker amplifier horn and handset units throughout the facility, to provide a complete and operational paging/intercom system, weatherproof and/or explosionproof units shall be utilized as required according to their location.
- B. The main components of this system in sufficient quantities shall be (but not be limited) to the following:
 - 1. Desktop Station, Model 726-102 (or latest equivalent). Single-Party Desktop Subset shall be approximately 4.81" (122.22mm) H X 10.46" (265.7mm) W X 9.35" (237.5mm) overall. It shall also include gray ABS handset with a 10 ohm, pressure differential, noise-canceling dynamic transmitter, 1 130 ohm, high efficiency dynamic receiver and a pressbar page switch for one-hand operation. All connections to the sublet are to be made through an eight foot (8') multi-conductor cable terminated by a connector which plugs into the bottom of the associated remote amplifier enclosure. A speaker and volume control shall be located on the front panel. The hookswitch mechanism shall be an electronic proximity detection circuit utilizing a sealed relay to eliminate exposed contacts.

2. Reflex Horns. The re-entrant horn shall be Model 13340 and possess constant directivity characteristics across the voice frequency band. The horn body shall be of high-impact, glass-reinforced polyester and shall have an air column length of 2.8' (.85m). A hot-dipped galvanized zinc "U" mounting bracket shall be affixed with stainless steel hardware to the horn body. Threaded throat area to accommodate screw-in driver shall have standard 1 3/8 - 18 UNEF thread. Dimension shall not exceed 15.63" (397mm) H X 27" (686mm) W X 14" (355.6mm) D. Dispersion angle shall be 120 degree horizontal, 60 degree vertical, maximum and nominal. The acoustical frequency response is 450-8,000 Hz. The low frequency cutoff is -10dB (350 Hz) and the high frequency cutoff is -10 dB (12 KHz). The dB level is 108 dBspl 1 watt at 1 meter.

The re-entrant horn, Model 13302-002, shall be reflexed, with reflector and bell of spun aluminum with epoxy coating and shall have an air column length of 3.5 feet (1.1m). A rib-reinforced steel "U" mounting bracket shall be affixed to the bell with fully serrated, adjustable joints and bracket position secured by self-locking nuts. All parts other than hardware, but including the mounting bracket, shall be epoxy coated. Dispersion angle is 50 degree nominal and efficient frequency range, 250-5200 Hz. Sound pressure level shall be 120 dB at 4 ft. (1.2m) on axis at 12 watt rated power.

3. Hazardous Area Station (FM and CSA Approval), Model 780-001, Hazardous Area Station - Indoor. Hazardous area single-party station shall be approximately 13.1" (332mm) H X 7.9" (200mm) W X 5.6" (143mm) D overall and have facilities for bottom entry for two 1.5" (38.1mm) (one plugged) conduit and a .75" (19.1mm) conduit entry in top. It shall also include a gray ABS handset with a 10 ohm pressure differential, noise-cancelling dynamic transmitter, and a 130 ohm, high efficiency dynamic receiver. This handset shall be operated through a safety barrier to limit voltage and current to an intrinsically-safe level. The page button shall be momentary, single action, and located on the front panel. The handset amplifier section shall have an output level of 1.5 Vrms (nominal) into a 33 ohm load. There shall be a 44 dB nominal voltage gain, an Automatic Gain Control Circuit, and a frequency response of 250 to 4,000 Hz.

The speaker amplifier section shall have a push-pull, Class B, 12 watt (minimum) output at nominal 120 VAC, with taps for 8 or 16 ohm voice coils. There shall be 20 dB maximum voltage gain into an 8 ohm load, and a frequency response of 250 to 4,000 Hz.

Equipment shall be approved by Factory Mutual suitable for Class I, II and III, Division 1, Groups C, D, E, F and G locations, and CSA for Class I, Division 1, Groups C and D; Class II, Division 1, Group E, F, G; Class III, Division 1 locations.

4. Hazardous Area Weatherproof Non-Metallic, Model 785-001. Hazardous area single-party weatherproof station shall have a hinged door with cam-style latch, and be built to NEMA 4 standards.

Components used to form the Hazardous Area Station may be rearranged by the installer for top entry of system conduit by following these instructions:

- a. Mount rear part of housing inverted.
- b. Invert P.C.B. sub-assembly inside rear housing to return it to proper orientation.

Equipment shall be approved by Factory Mutual for Class I, II and III, Division 1, and CSA.

5. Speakers, Compact Paging Speaker with Built-In Drivers. Speaker shall be Model 13350 direct-radiating horn with an asymmetrical shape for efficient sound dispersion and equipped with built-in driver. Frequency response shall be 450-4500 Hz \pm 5 dB and dispersion shall be 90 degree. Horn assembly shall be constructed of high-impact, glass-reinforced polyester. Sound pressure level shall average 118 dB at 3.3 ft (1m) on axis at 12 watt rated power. Voice coil impedance shall be 8 ohms. Power handling capacity shall be 16 watts rms. Horn shall be

shall be equipped with two integral .75" (19.05mm) conduit entries and a terminal block for wire termination.

6. Two-Way Horn, Model 13305-001. Shall have two double-reflexed horns, with reflectors of high impact Butyrate, bells of spun aluminum with epoxy coating and tone arms of die-cast aluminum. The horns shall face in opposite directions and be joined by a cast aluminum "T" acoustic coupler. It shall be possible to use a driver unit up to 5" diameter having 1.38" (35.1mm) -18 thread screwed directly into the acoustic coupler. Each bell mouth diameter shall not exceed 8.5" (215.9mm) and shall have a dispersion angle of 70 degree nominal. Low frequency cut-off shall be rated as 400 Hz. Heavy gauge stamped steel "S" shaped mounting bracket shall connect directly to the acoustic coupler in such a way as to permit variation in projection angle approximately 10 degree outward from both horns. Sound pressure level shall be 116 dB at 4 ft (1.2m) on axis at 12 watts rated power when used with driver.

7. Heavy Duty Drivers. Driver shall be Model 13314-002 and approved by Underwriters Laboratories for use in Division 2 areas. Driver power handling capacity shall be 30 watts with a frequency response of 300 or 4,500 Hz ± 6 dB. Voice coil shall have an impedance of 16 ohms. Sound pressure level shall be 111 dB at 1 watt; 1 meter (swept sine average) with reflect horn, a 3.5 ft. (1.1m) air column re-entrant type horn. Complete housing assembly shall be weatherproof molded LEXAN equipped with 1.38" (35.1mm) -18 threads for screw-in connection to horn.

The explosionproof driver shall be Model 13315-002 and approved by Underwriters Laboratories for use in hazardous areas specifically designated as Division 1, Class 1, Groups B, C, and D; and Class II, Groups E, F, and G. Driver shall have a full range power capacity of 30 watts continuous power. Frequency response shall be 300 to 4,500 Hz (± 6 dB). Voice coil shall have an impedance of 15 ohms. Sound pressure level shall be 106 dB at 1 watt, 1 meter (swept sine average) with reflex horn. Case shall be heavy die-cast aluminum, epoxy coated with dimensions not exceeding 7.875" (19.8mm) in diameter and 7.56" (19.2mm) in length.

8. Cone Speaker Assemblies. Ceiling speaker assembly shall be Model 804 and consist of an enclosure, baffle, and 8" cone speaker and related mounting hardware. The unit shall be factory assembled and wired, ready for installation. The enclosure shall measure 10.1" (255.6mm) diameter X 4.25" (107.9mm) deep. It shall be constructed of heavy gauge steel and be heavily undercoated. The baffle shall be an aluminum trim ring 12.6" (320.7mm) in diameter. The frequency response shall be 230-7,000 Hz with a power handling capacity of 7 watts. The voice coil impedance shall be 8 ohms. The unit shall have a remote volume control arranged to mount in a standard electrical switch box.

9. Weatherproof Wall Station, Non-Metallic Enclosure, Model 730-104, Handset/Speaker Amplifier. Single-party and speaker amplifier non-metallic enclosure shall be made from glass-reinforced polyester approximately 14.6" (371mm) H X 10.9" (276mm) W X 10.5 (267mm) D overall, shall have a hinged door with cam-style latch, and built to NEMA X standards. It shall contain a receptacle to mate with plug-in handset/speaker amplifier, and double-row terminal strips for connection of field wiring. Hubs for conduit entrance shall not be supplied, because field installation is simple and conduit entrance/exit can be made in the most convenient location. A template is provided to simplify installation. The shipping weight shall not exceed 9.3 lbs (4.2kg).

Single-party metallic enclosure shall be cast aluminum, approximately 14.9" (378mm) X 10.6" (270mm) W X 9.6" (244mm) D overall, shall have a hinged door with cam-style latch, and built to NEMA 4 standards. It shall contain a receptacle to mate with plug of plug-in handset/speaker amplifier, and double row terminal strips for connection of field wiring. 1-1/4"

1/4" (31.8mm) conduit hubplates shall be provided on booth top and bottom. The shipping weight shall not exceed 19.5 lbs (8.89kg).

Weatherproof wall stations shall be approved by Factory Mutual as non-incendive for Class I, Division 2, Groups A, B, C, D; suitable for Class II, III, Division 2, Group G and SCA for Class I, Division 2, Groups A, B, C, D; Class II, Division 2, Groups E, F, G; Class III, Division 2 locations.

10. Flush Panel Station, Model 715-004. Single-party sublet shall be approximately 6" (153mm) H X 3.5" (89mm) W X 2.5" (63.5mm) D behind panel and be mounted through four (4) .25" diameter holes in the subset panel. Panel cutout shall be 2.5" (63.5mm) W X 4.86" (123.6mm) H X 2.5" (63mm) D. It shall also include a gray ABS handset with a 10 ohm, pressure differential, noise-cancelling dynamic transmitter, a 130 ohm, high efficiency dynamic receiver, and a pressbar page switch for one-hand operation. All connections to the subset are to be made through an eight foot (8') multi-conductor cable terminated by a connector which plugs into the bottom of the associated amplifier enclosure. The hookswitch shall be of proximity detection circuit utilizing a sealed relay in the amplifier to eliminate exposed contacts.

11. Cabling. Shall be as specified by the equipment manufacturer and furnished by the communications system installer.

B. Equipment shall be new and the latest design of a manufacture who is regularly engaged in the production of the specified products. The surfaces of the equipment shall have the manufacturer's standard corrosion resistant finish.. Type numbers in this paragraph are Gai-Tronics, and are intended to indicate the quality of design for the products. Nameplates shall be provided for pushbuttons, switches and pilot lights.

2.03 WIRING

A. System wiring and equipment installation shall be in accordance with good engineering practices as established by the EIA and the NEC. Wiring shall meet all state and local electrical codes. All wiring shall test free from all grounds and shorts.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL

A. Provide all the communication equipment installations and wiring installations, and tests as indicated, specified and required. Assure proper fits for all equipment and materials in the locations shown on the drawings.

3.02 TELEPHONE INSTALLATIONS

A. Provide all the required concrete, earthwork, manholes, handholes and pullboxes. Install the terminal cabinets, wood backboards, telephone outlets, conduits, cables, supports, pull wires and grounding as indicated and required. The telephone installations shall conform to the requirements of the telephone company.

3.03 COMMUNICATION SYSTEM INSTALLATIONS

- A. The communication system shall be installed by an authorized contractor for the manufacturer of the communication equipment. Provide the complete equipment installations and wiring installations as indicated, specified and required by the manufacturer.

3.04 TESTS

- A. All the equipment and cables shall be checked for proper installations and connections.
 - 1. Test Plan. Prepare the demonstration and final operation test plan as specified in Section 16010.
 - 2. Supervision. Provide the manufacturer's supervision and field installation check as specified in Section 16010.
 - 3. Field Tests. Provide the field tests and adjustments on the equipment and wiring as recommended by the equipment manufacturer.
 - 4. Operational Tests. Demonstrate that performance of the installed communication equipment and materials complies with the requirements of the project documents, and to the satisfaction of the City Engineer.
 - a. Remote speakers shall be tested for volume and clear voice message delivery.
 - b. Defects and malfunctions shall be corrected with approved methods and materials.

3.05 REPORTS

- A. The equipment manufacturer, or his authorized representative shall submit certified reports for the installations as specified in Section 16010.

3.06 TRAINING – NOT USED

END OF SECTION

SECTION 14200

HYDRAULIC PASSENGER ELEVATOR

PART 1 - GENERAL

1.01 DESCRIPTION OF SYSTEM

- A. Provide all labor, materials, tools and equipment, including all appurtenances and auxiliaries to make elevator assembly fully operational and capable of performing as indicated, specified, required, and in accordance with all state and local codes. This specification provides a guide of items to be included and a detailed description is provided only for items of special manufacturer or type. The Company must examine the drawings and specifications carefully and include all items normally required for a complete and safe job. Workmanship shall be best quality and in compliance with best practices. In general, work includes but is not limited to the following major items:

1. One (1) hydraulic passenger elevator to serve two (2) floors.

B. Related Work.

1. A legal hoistway, properly framed and enclosed, and including a pit of proper depth, provided with ladder, drains, lights, access doors, and waterproofing, as required. Suitable machine room, adequate for the elevator equipment, including floors, gratings, foundations, lighting, ventilation and heat to maintain the room at a temperature of 50° F minimum to 100° F. maximum, or as required by Florida State Elevator Inspectors and Code.
2. Adequate supports and foundations to carry the loads of all equipment, including supports for guide rail brackets and machine beams or overhead sheaves (if furnished).
3. Suitable connections from the power mains to each controller or motor generator set starter, signal equipment feeders as required, including necessary circuit breakers and fuse mainline disconnect switches.
4. Electrical outlets and pit lighting shall be provided in the elevator hoistway as shown on the elevator layout drawings. Electric power without charge for construction testing and adjusting of the same characteristics as the permanent supply shall be provided when required.
5. All sill recesses and the grouting of door sills and hoistway frames after installation.
6. All painting, except as otherwise specified.
7. Provide temporary enclosures or other protection from open hoistways during the time the elevator is being installed.
8. Proper trenching and backfilling for any underground piping or conduit.
9. Furnish and install telephones in elevator car. Elevator contractor to furnish wires in the traveling cable for telephone hook-up. Note that an automatic dial telephone must have emergency power provision in order to operate.
10. Provide heat and smoke detectors per ANSI/ASME A17.1 and NFPA #72E.
11. The Florida Code requires that the machine room door shall be Class B label led and the machine room vent shall be fusible link louvered (except when the smoke vent is in the machine room floor).

C. Related Sections:

1. Section 05500 - Miscellaneous Metals.
2. Division 15 - Mechanical.
3. Section 16721 - Fire Detection and Alarm System
4. Division 16 - Electrical.

1.02 QUALITY ASSURANCE

- A. Furnish components and accessories by one manufacturer. Acceptable manufacturer for the purposes of establishing a basis of design, Dover, Model No. Marquis 25, or approved equal.
- B. Qualifications: In the interest of unified responsibility, the Elevator Company shall be one regularly engaged in the business of manufacturing, installing and servicing elevators of the type and character required by these specifications and he shall manufacture the entire power unit, controller, hydraulic cylinder and all other parts of the equipment including door operators.
- C. The elevator manufacturer shall submit evidence indicating a minimum of ten (10) years experience in design and fabrication of this equipment. Submittal shall also include the following:
 1. List of ten (10) similar installations arranged to show name of project, elevator capacity, speed, travel and date of completed installation. The ten (10) elevators shall be located within twenty (20) miles of the installation described herein.
 2. Completed literature, performance and technical data describing the proposed equipment.
 3. List of twenty (20) service accounts by building name, building manager or owner within 50 miles of this installation.
 4. Location of closest service office from which this elevator will be maintained.
 5. Location of closest parts inventory for this installation.
- D. Components, accessories, fabricated parts, and structural requirements shall comply with:
 1. Florida Building Code (FBC).
 2. Americans with Disabilities Act and Accessibility Guidelines (ADA).
 3. Bureau of Elevators of the Department of Business Regulation as per Chapter 399 of the Florida Statutes.
 4. National Electrical Code -1999 (NEC).
 5. Occupational Safety and Health Act (OSHA).

1.03 SUBMITTALS

- A. Prior to commencing work, submit the following information for approval in accordance with Appendix 5 of the Service Contract.
 1. Samples: Submit in duplicate
 - a. Cab interior cuts
 - b. Hoistway entrance cuts
 - c. Finish samples and selection charts for each item to be selected
 - d. Signal fixture cuts
 2. Dimensional shop drawings.
 - a. Machine room plans

- i) Location of equipment
 - ii) Service connections
 - iii) Loads
 - iv) Room dimensions
 - v) Connection details
 - vi) Other trade requirements/coordination
- b. Hoistway sections for elevator
 - i) Vertical and horizontal
 - Bracket spacing
 - Estimated forces on rails
 - Estimated forces in pit.
- B. Electrical requirements, schematics, etc.
- C. Operation and maintenance manuals per Appendix 11 of the Service Contract. Include a separate parts list of those parts for which an extended time delay can be expected.

1.04 CODE REQUIREMENTS

- A. All Design-Build Work shall be performed in accordance with the latest revised edition (as of the date bids are taken) of the American National Safety Code for Elevators, Dumbwaiters, Escalators, and Moving Walks (ANSI A-17.1), the National Electrical Code, and/or such State and Local codes as may be applicable.

1.05 PAINTING

- A. All exposed metal work furnished by the Elevator Company under these specifications shall be properly painted by the Elevator Company after installation, in accordance with Section 09905, except as otherwise specified.

1.06 PERMITS, TAXES AND LICENSES

- A. All applicable county and state sales and use taxes, permit fees, inspections and licenses, as of the date bids are taken, shall be paid for and coordinated by the Company. All tests and inspections shall be made in the presence of the City Engineer.

1.07 TEMPORARY SERVICE

- A. Should the service of the elevator be required before completion and final acceptance, permission in writing must be obtained from the City. In addition, the Company shall agree to sign the temporary acceptance form and be bound by the terms and conditions thereof.

1.08 MAINTENANCE SERVICE

- A. The Company shall furnish maintenance and callback service on the elevator after it is completed and placed in operation for a period of twelve (12) months from the date of substantial completion of the elevator. This service shall consist of examinations of the equipment, adjustments, lubrication, cleaning, supplies and parts to keep the equipment in proper operation, except such adjustments, parts or repairs made necessary by abuse, misuse or any other causes beyond the control of the

control of the Company. All work will be done by trained employees of the Company during regular working hours of the trade.

- B. Include monthly preventive maintenance, performed during normal working hours.
- C. Include repair or replacement of worn or defective parts or components and lubrication, cleaning, and adjusting as required for proper elevator operation according to specified requirements.
- D. Include 24 hours a day, 7 days a week emergency callback service.

1.09 WARRANTY

- A. The Elevator Company shall warrant the equipment installed by him under these specifications against defects in materials and workmanship and will correct any defects not due to ordinary wear or tear or improper use or care which may develop within one (1) year from the date of substantial completion. This warranty is not intended to supplant normal maintenance service and shall not be construed to mean that the Elevator Company will provide free service for periodic examination lubrication or adjustment due to normal use beyond that included in the specifications; nor will the Elevator Company correct, without charge, breakage, maladjustments, or other trouble arising from abuse, misuse, improper or inadequate maintenance, or any other causes beyond his control.

PART 2 - PRODUCTS

2.01 GENERAL ELEVATOR REQUIREMENTS

- A. One (1) passenger elevator - Dover Oildraulic or equal.
 - 1. One (1) Dover Marquis 25 passenger elevator, with Class A loading capacity.
 - 2. 2500 pound capacity
 - 3. 125 FPM up and down
 - 4. Two (2) landings
 - 5. Two (2) openings
 - 6. Approximate travel distance: 15' 6"
 - 7. Power unit with internal oil tank, submersible pump and unitized valve, oil silencer, isolation couplings, low oil protective device and sound isolation panels for quiet operation and protective covers for electrical control panel.
 - 8. Car platform inside dimension: 6'-8" wide x 4'-3" deep.
 - 9. Integrated Microprocessor control. Two-way leveling.
 - 10. Oildraulic operation. Machine room first floor, adjacent.
 - 11. Car design: Dover DLP-I cab with stainless steel front return. Door, side and walls to be covered with 1/16" H.P. plastic laminate, suspended plastic light diffuser, baked enamel steel frame, fluorescent fixtures, telephone compartment, car position indicator, emergency light, alarm bell, stainless steel continuous handrails, electronic door sensing device, oil line shut off valve, jack cylinder installed in PVC tube per Florida State law, sound isolation couplings, oildraulic "silencer"; NEMA 1 controller cabinet, fan, and emergency service in accordance with ANSI - A17.1. All components and elevator cab design to conform with ANSI A17.1, Florida State Accessibility Code and American with Disabilities Act.

12. Car floor: by General Company
13. Hoistway doors 3'-6" x 7'-0" one (1) speed, horizontal sliding, DC power, gearless. Right Hand.
14. Signals: Illuminating car and halt station push buttons. Handicapped features per requirements to include car station with raised numerals and letters, car position indicator with audible signals, car riding lantern with one (1) audible signal for up and two (2) audible signals for down, door jamb markings.
15. Special features: Accessibility as ADA and the Florida State Accessibility Code. Braille symbols per handicapped Code. Pit Ladder.
16. Electric Service: 3 phase, 60 HERTZ, 480 Volt.
17. Vandal Resistant Speakerphone
18. Outside Alarm Bell and Sign
19. Emergency Lights In Car
20. Service Lights
21. Inspection Operations Control Unit

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine hoistway and machine rooms and report any irregularities.

3.02 INSTALLATION

- A. Install each elevator in accordance with the manufacturer's directions and in compliance with all local, state, and OSHA codes.

3.03 ADJUST AND CLEAN

- A. Adjust and lubricate as per the manufacturer's directions.
- B. Clean up and remove all loose material, dirt, oil and grease from the machine room, hoistway, surrounding areas and any area used for work space.
- C. Prior to scheduling inspection by the jurisdictional authorities, test operate the equipment, performing all functions at each landing. Adjust and lubricate as necessary.

END OF SECTION

SECTION 14600
CRANES AND MONORAILS

PART 1 - GENERAL

1.01 SCOPE

- A. Overhead bridge crane and monorail systems including tracks (ASCE rails), trolleys, hoists, jib cranes, controls, and accessories as indicated and required.
- B. Related Sections include but are not necessarily limited to:
 - 1. Section 01600: Materials and Equipment
 - 2. Division 3: Concrete.
 - 3. Section 05120: Structural Steel
 - 4. Section 09905: Painting and Protective Coatings.
 - 5. Division 13: Special Construction
 - 6. Division 16: Electrical.

1.02 SUBMITTALS

- A. The following submittals are required for this equipment:
 - 1. Manufacturer's Product Data (system brochure, trolleys, hoists, control panels, electrical panels, cables, hooks and accessories)
 - 2. Shop Drawings (outline dimensions, assembly plans & sections, general arrangement, control schematics, point-to-point wiring diagrams showing all terminals annotated, panel layout, annotated ladder logic, equipment weights, anchorage requirements, and support requirements)
 - 3. Test Reports, Load Test Certificate, Hoist Hook Certificates, Wire Rope Certificates, and set-point adjustments.
 - 4. Operation and Maintenance Manuals (including installation instructions, parts lists, recommended spare parts, and warranty data)
 - 5. Support load calculations, structural design calculations for runway beams and associated supports and components and jib crane, which is sealed and signed by State of Florida Professional Engineer.

1.03 PERFORMANCE GUARANTEES

- A. General: Guaranty compliance of the crane, monorail and jib crane systems and indicated components with the performance requirements identified herein.
- B. Unit Capacity: Lift, move, and set test loads at rated capacity indicated for each unit.
- C. Unit Performance: Equipment components (i.e. bridge, trolley, and hoist) operate over the full speed range indicated for each unit.
- D. Unit Coverage: Each unit provides access to lift process equipment within indicated coverage area.
- E. As per OSHA regulations, each bridge crane and monorail hoist or jib crane will be given a 125% load test. A load test certificate will be supplied after test is complete.

1.04 WARRANTY

- A. All equipment supplied under this section shall be warranted for a period of two (2) years from startup by the Company and the Manufacturer. Distributor warranties will not be acceptable.
- B. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced in the machine(s) and the unit(s) restored to service at no expense to the City.
- C. The Manufacturer's warranty period shall run concurrently with the Company's warranty period. No exception to this provision shall be allowed.

PART 2 - PRODUCTS

2.01 MANUFACTURERS/SUPPLIERS

- A. Provide crane and monorail systems and jib crane systems including necessary equipment and appurtenances as manufactures by the following manufactures:
 - 1. Material Handling System, Inc.
 - 2. FHS, Inc.
 - 3. American Crane and Equipment Corporation
 - 4. Or approved equal.

2.02 DESIGN REQUIREMENTS

- A. General: Design crane and monorail components including monorail tracks, runway beams, brackets, framework and jib cranes using standard structural steel shapes conforming to ASTM A36, and welding standards conforming to AWS D14.1, in accordance with Section 05120, ANSI MH27.1, ANSI B30.11, and Crane Manufacturers Association of America (CMAA) specifications.
- B. Bridge Crane Criteria: Design an integrated bridge crane system including rails, girders, trucks, wheels, trolley, hoist, cable, hook, power wiring, controls and accessories as indicated.
- C. Default Service Class: Design all cranes for CMAA CLASS C and monorails for HMI Class H3 Class A1 service as described in ANSI MH27.1 unless otherwise indicated.
- D. Jib Crane Criteria: Design a freestanding jib crane system including base plate mount, trolley end stops, manual chain hoist and push/pull trolley as indicated.

2.03 BRIDGE CRANE

- A. Bridge Assembly: Provide top running or under-hung, double or single girder type bridge assembly as indicated. Design girder section to limit deflection under full load to less than 1/600th of span but not to exceed 1¼-inch. Brace bridge assembly to maintain square with end trucks.
- B. End Trucks: Weld each end truck frame using high strength structural tubing conforming to ASTM A500 or structural steel shapes conforming to ASTM A36 to form a rigid box section to maintain alignment and distribute loads to all wheels. Provide bumpers with sufficient energy absorbing capacity to stop a loaded crane travelling at 40% rated speed. Equip bridge trucks with sweeps extending below the top of the rail and projecting in front of crane wheels.
- C. Crane Wheels: Provide double flanged, steel wheels designed to rotate on rotating axles with hardened steel treads (> 225 Brinell hardness). Support each wheel on factory, lifetime lubricated

precision ball or roller bearings designed for imposed radial and thrust loads. Design wheel mounting to allow bearing adjustment and removal without disturbing truck alignment.

- D. Crane Drive: Provide fully enclosed electric motor drive with integral, oil splash lubricated reduction gear for each end truck. Provide a spring set, electrically released, disc type brake on each reducer in line with the motor. Support the reduction gear shaft on precision ball or tapered roller bearings designed for minimum 5,000 hours B-10 bearing life.
- E. Runway Beams and Rails: Provide ASCE type rails securely fastened into runway beams. Design beams to limit deflection less than or equal to 1/800th of span. Equip beams with stops at both ends capable of withstanding impact of loaded crane at 50% rated speed. Provide necessary brackets, clamps, hanger rods, bolts, and fittings for attachment of runway beams to supporting building structure. Crane runway beams shall be engineered and provided by the crane supplier. Engineering calculations shall be a part of the submittal package.
- F. Bridge Catwalk: Provide steel catwalk on bridge assembly where indicated covering full span with grating type deck and OSHA compliant handrails. Configure catwalk and coordinate with building structure to minimize impact on coverage area and allow access. Design catwalk deck to accommodate 50-psf live load.
- G. Field painting requirements are as specified under Section 09905.

2.04 ELECTRIC TROLLEY AND HOIST UNITS

- A. Trolley General: Provide an under-hung or top mounted trolley on each unit as indicated. Construct trolley frame using welded steel plates, angles, and channels to form a rigid, one-piece unit with adequate bracing to withstand vertical, lateral, and torsional forces. Machine trolley frame surfaces as required to accommodate hoist and traverse mechanisms.
- B. Trolley Stability: Provide stabilizing roller assembly for trolley units mounted on single girder bridge assemblies and monorails to prevent tipping during load pick-up. Provide stops at each end of the bridge assembly or monorail to limit trolley travel.
- C. Trolley Wheels: Provide rolled or forged steel wheels with heat treated treads (> 225 Brinell) and flanges. Alternatively, provide cast iron wheels with chilled tread. Design wheels for attachment to rotating axles and provide pre-lubricated and sealed bearings designed to accommodate both radial and thrust loads.
- D. Traverse Drive: Provide fully enclosed, side mounted variable frequency drive electric motor with integral, oil splash lubricated reduction gear to traverse the bridge crane or monorail span. Equip trolley with adjustable torque shoe or disc type magnetic brake.
- E. Hoist General: Provide hoisting machinery for each unit including drive motor, reduction gear, drum, lifting tackle, and hook. Provide adjustable upper and lower limit switches for hoist hook travel. Design hoist for service class H3 as described in ANSI HST4M unless otherwise indicated.
- F. Hoist Drive/Drum: Provide two speed, electric motor drive coupled to a fabricated steel winding drum through helical or spur type reduction gears. Size drum assembly to accommodate indicated load capacity and travel range with at least two turns of hoisting cable remaining on the drum with the hook in its low position. Design gears and bearings to operate in a sealed housing with positive oil splash lubrication. Construct drum with enclosed load blocks to minimize cable abrasion, crushing, or jamming. Provide electromagnetic type brake rated for capacity load and configured to set automatically when no current through hoist motor.

- G. Lifting Tackle. Provide cable system including flexible plow steel wire rope, grooved support sheaves, and connection hardware required to accommodate the indicated load and lifting condition in accordance with CMAA specifications.
- H. Hook: Provide forged steel hook with spring loaded safety latch. Provide semi-enclosed hook block, bearing assembly allowing 360-degree rotation of lifted loads.

2.05 MANUAL TROLLEY AND HOIST UNITS

- A. Hoist and Trolley Combination:
 - 1. Provide hand chain hoists that can be suspended from push trolleys. The suspension method for coupling the hoist to the push trolley shall be hook to lug.
 - 2. Hand chain hoists shall have:
 - a. All-steel construction including gear case enclosure and handwheel cover
 - b. Low headroom
 - c. Compact design
 - d. Efficient drive train
 - e. Standard slip clutch device
 - f. Double pawl springs for operation of brake mechanism
 - g. Double enclosed brake cover that keeps out dust, rain, and dirt
 - h. Grade 100 heat-treated manganese alloy load chain
 - i. Forged and heat-treated alloy steel hooks
 - j. Test certificate stating each unit has been factory load tested to 125% of rated capacity, in accordance with ASME B30.16 requirements
 - 3. Push trolleys shall have:
 - a. Contoured wheels that fit both tapered and flat-flange beams
 - b. Maintenance-free, sealed precision, lubricated ball bearings
 - c. Compact design
 - d. Adjustable trolley to fit varying beam flange widths
 - e. Load equalizing suspension

2.06 JIB CRANE

- A. Provide jib cranes designed in accordance with the AISC Steel Construction Manual, taking into account both deflection and stress, L/150 or better.
- B. All holes in steel with bearing loads shall be punched or drilled. Flame cut holes are not allowed.
- C. Jib crane shall have a shop applied, high solids industrial baked enamel finish.
- D. Concrete for jib crane foundation shall be 3000 lbs. per square inch of compressive force.

2.07 ELECTRICAL

- A. Electric Motors: Provide constant speed induction motor conforming to Section 16150 with an open drip proof (ODP) enclosure for each crane, trolley, and hoist drive. Select motor size with nameplate rating equal to, or in excess of, maximum normal load that will be imposed at any point in the operating range of the design conditions specified. Each motor shall have a 1.15 service factor with Class "F" insulation.

- B. Conductors and Wiring: Provide insulated, figure eight enclosed, safety type runway conductors for bridge cranes and provide festooning for power and control of hoist and trolley on bridge cranes. Provide festooned cable type conductors for trolley/hoist units. Provide wire in rigid, galvanized steel conduits with watertight fittings and junction boxes for wiring fixed to crane structural elements. Short lengths of flexible steel conduit with a watertight covering can be used to make connections to control devices, such as limit switches or equipment subject to vibration.
- C. Panels: Provide electrical equipment including starters, disconnects, circuit breakers, terminal strips, and accessories in NEMA 4X stainless steel enclosures conforming to requirements in Division 13.

2.08 CONTROLS

- A. Provide wireless Radio remote control type control with sliding push button back up station for each bridge crane and monorail with storage receptacle on the associated main electrical panel. Provide forward, stop, reverse pushbuttons for trolley drive and up, stop, down pushbuttons for hoist drive on each control station. Also provide forward, stop, reverse pushbuttons on bridge crane control station. Provide 2 step buttons for all motions with a maintained on/off.
- B. An emergency disconnect switch shall be provided by the electrical contractor in coordination with the crane supplier.

2.09 SPARE PARTS

- A. Provide inventory of consumables such as lubricants required for normal operation and maintenance of crane equipment during the warranty period (12 months).
- B. Provide the Manufacturer's recommended spare parts.

PART 3 - EXECUTION

3.01 COORDINATION AND INSTALLATION

- A. Verify coordination of crane/monorail and jib crane dimensions and support attachments with building structure.
- B. Verify compatibility of crane/monorail and jib crane load capacity, coverage limits, and hook height range with dimensions, weights, and locations of installed equipment.
- C. Verify wireless control range compatible with access limitations established by building, process equipment, and crane/monorail layout.
- D. Install crane/monorail and jib crane components in accordance with manufacturer's instructions.
- E. Runway rails shall be installed to meet the positioning tolerances specified in CMAA-70 specification. Provide rails adjustments, if required, to achieve the tolerances.

3.02 INSPECTION, TESTING AND START-UP

- A. Provide inspection, testing, and start-up services as indicated below:
 - 1. Shop Testing (crane drives, trolley drives, hoist drives, hoist drums, hoist cables, wheels)
 - 2. Certificate of Proper Installation (each crane/monorail system)
 - 3. Functional Acceptance Testing (bridge travel range as applicable, trolley travel range, and hoist travel range each unit)

4. Operation and Maintenance Training (start-up, shut-down, lubrication checks, performance monitoring, record keeping, and troubleshooting)
5. Performance Testing (lift, move and set test load each unit)

3.03 MONITORING AND CONTROL REQUIREMENTS

- A. General: Sequence descriptions presented herein together with parameter ranges and suggested setpoints incorporate implicit assumptions regarding the component characteristics and overall configuration of each crane/monorail system. While vendor specific differences in components and configuration may require some adjustment in sequence descriptions, instrument ranges and operating setpoints, all functions indicated herein must be included in the completed system.
- B. Related Systems Interfaces. Import and export monitoring and control data from the ICM as required for related Facility operations and data archiving as indicated herein.
 1. Provide signals to ICM indicating run status for bridge drive if applicable, trolley drive, and hoist drive for each crane/monorail system.

END OF SECTION

SECTION 15060

PIPING AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Company shall furnish all tools, equipment, materials and supplies including all labor required for complete installation, testing, disinfection, and flushing of piping and appurtenances as shown on the drawings and specified herein.

1.02 SCOPE OF WORK

- A. Design-Build Work Included in this Section. The Design-Build Work of this section shall include the furnishing, installation, and testing of pipe, pipe supports, fittings, restrained joints, expansion joints, and all required appurtenances as shown on the drawings and as required to make the entire piping system operable. The systems include but are not limited to sewage, water, air, chemical, drainage, and piping. The Design-Build Work shall include, but not be limited to, the following items:
 - 1. Piping involved in the plant process functions.
 - 2. Piping for the introduction of chemicals and other materials into the systems being treated.
 - 3. Piping for system quality sampling.
 - 4. Pump discharge, manifold and branch piping.
 - 5. Piping for the introduction of air into the systems being treated.
 - 6. Inlet and outlet pipelines.
 - 7. Tank drains.
 - 8. Plant water systems for the distribution of potable water.
- B. Related Design-Build Work Specified in other Sections:
 - 1. Trenching, Backfilling and Compaction
 - 2. Process Valves and Regulators
 - 3. Painting and Protective Coatings
 - 4. Miscellaneous Metals
 - 5. Plumbing
 - 6. Earthwork and Site Preparation
 - 7. Steel Pipe

1.03 CONTRACTOR SUBMITTALS

- A. General. Shop drawings, together with other required information specified, shall be submitted in accordance with the requirements of Appendix 5 of the Service Contract and the requirements specified in this Section.
- B. Shop Drawings. Shop drawings, complete with material, grade, and class for all pipe, fittings, and couplings and for all joints, coatings, and appurtenances shall be submitted. Detailed catalog and

engineering data sheets shall be submitted for all components such as flexible couplings, rubber gaskets, and proposed schedule for delivering and installing the piping shall be included.

- C. Erection Procedure. A set of written procedures for performing the field piping installation. The procedures shall cover in detail the preparation and making of the push-on, restrained, mechanical, flanged, grooved, welded, caulked, flared, hard-soldered, chemically-welded and screwed joints and couplings; measures to ensure integrity of interior pipe lining and exterior protective coating at all joints and couplings; the method of backing up and sealing the annular spaces in pipe sleeves; and the installation and adjustment of pipe hangers and other supports.
- D. Protective Coating. A protective coating schedule shall be submitted, showing shop and field surface preparations, materials, methods of application, dry thicknesses and tests for defects, all in conformance with Section 09905, "Painting and Protective Coatings".
- E. Testing Procedures. Procedures for testing the piping, and arrangements for obtaining and disposing of water for the tests shall be fully described. The equipment for testing shall be itemized. Details of bulkheads, flanges, or caps for the testing of the pipe shall be included with the submittal.
- F. Disinfection. Procedures for disinfection of potable water piping shall be fully described including the type of chlorine used, method of application, and details of bulkheads, corporation cocks, caps and chlorine feeding equipment.

1.04 PRODUCT HANDLING, DELIVERY AND STORAGE

- A. General. Pipe shall at all times be handled with equipment designed to prevent damage to the interior or exterior coating of the pipeline.
- B. Shipping. When making shipments, all chains, cables and hold-down equipment shall be carefully padded where in contact with the pipe. Shipped pipe shall be stacked in accordance with the manufacturer's recommendations.
- C. Unloading. Unloading from the trucks shall be done with care using slings as indicated above for steel pipe or appropriate slings and cables for ductile iron pipe. No pipe shall be allowed to fall from trucks. Pipe shall only be unloaded using a crane or fork lift.
- D. Gaskets. Gaskets shall be stored in containers or wrappers which will protect the gaskets from ozone and other atmospheric deterioration.
- E. Storage. Storage of pipe prior to installation shall be in strict accordance with the manufacturer's recommendations.

1.05 JOB CONDITIONS

- A. For purposes of clarity and legibility, the drawings are essentially diagrammatic to the extent that many offsets, bends, and special fittings and exact locations are not indicated. Company shall carefully study the drawings and determine for himself the extent of the Design-Build Work and include in his bid all necessary bends, fittings and specials to install the Design-Build Work in conformance with the Design Documents.

PART 2 - PRODUCTS

2.01 GENERAL

- A. General Requirements. All pipe, fittings, couplings, and appurtenant items shall be new, free from defects or contamination, and wherever possible, shall be the standard product of the manufacturer. They shall be furnished in pressure or thickness classes as specified or shown. Unless otherwise indicated the size shown shall be the nominal pipe diameter.
- B. Length. All pipe smaller than 60-inches shall be furnished in a maximum of 20 foot lengths, unless indicated otherwise. Carbon Steel and Stainless Steel piping shall be provided in maximum 40 foot lengths.
- C. Raised Face Flanges. When carbon steel or stainless steel flanges or flanged valves with raised face will be bolted directly to flat faced FRP, plastic, or cast iron flanged fittings or valves, the raised face shall be removed or spacers approved by the valve or pipe manufacturer shall be installed to allow bearing over 100 percent of the flange area.
- D. Joints. All pipes above ground shall have screwed, grooved or flanged joints, unless otherwise specified. Welded pipes will be permitted, provided that there are sufficient flanges or unions at valves and equipment to permit easy disassembling. Buried pipes shall have restrained bell and spigot or mechanical joints, unless welded, flanged or other joints are shown or specified. Under no circumstances shall any piping 3-inches and larger be provided with screwed ends.
- E. Mechanical Couplings and Expansion Joints. Pipe mechanical couplings and expansion joints shall be provided at locations shown on the drawings as a minimum requirement.
- F. Screwed Flanges. Where pipe is furnished with screwed on flanges, the flange is to be screwed tight on the pipe until the pipe end projects beyond the face of the flange. The flange shall then be machine faced to give a flush finish of the pipe and flange. Flanges shall have a minimum rating of 125 pounds and shall be 250 pounds minimum for all service in excess of 150 psi working pressure. Screwed on flanges shall be factory installed.
- G. Minimum Wall Thickness. Where mechanical couplings or threaded flanges or unions are provided, the minimum specified wall thickness or rated working pressure shall be maintained at the grooves, slots, and threads.
- H. Bolting. Unless specified otherwise, bolting used for joining pipe shall be carbon steel which conforms to the requirements of ASTM 307 Grade B. Bolts shall be the USA standard heavy hexagon head and nuts shall be USA standard heavy hexagon dimensions.
- I. Pipe Materials. Pipe materials shall conform to the piping schedule included in this Section, unless shown otherwise on the drawings.

2.02 STEEL PIPE (CS)

- A. Steel pipe 6-inches and smaller shall be seamless carbon steel conforming to the requirements of ASTM A-53 Grade A.
- B. Unless otherwise specified or shown, steel pipe shall be grooved end, Schedule 80.

- C. Fittings shall be flanged end, unless otherwise shown, segmentally welded and fabricated from Schedule 80 steel wall pipe conforming to the requirements of ASTM A-53, Grade A.

2.03 BLACK STEEL PIPE (BST)

- A. General. Black steel pipe shall be welded and seamless steel pipe conforming to ASTM A53, standard weight or Schedule 80. End finish shall be threaded, plain ended, welded, or flanged as indicated on the Drawings.

1. Threaded Ends. Conform to ANSI B1.20.1.
2. Flanged Ends and Gaskets. Conform to ANSI B-16.5. Class 150 or Class 300 rating. Gaskets shall be 1/8-inch red rubber or equal, full face type.

Steel flanges shall be welding neck type or double fillet welded, slip-on type. A single fillet weld shall not be used to attach the flange to the pipe.

- B. Fittings and Joints. Provide threaded fittings or welding fittings as indicated on the drawings.

1. Threaded Fittings. Black malleable iron conforming to ANSI B-16.3; Class 150. Malleable iron shall conform to ASTM A-47.
2. Welding Fittings. Steel conforming to ASTM A-234, standard weight.
3. Welded Joints. Conform to ASME Boiler Code, Section IX.

2.04 STAINLESS STEEL PIPE (SS)

- A. General. Piping shall be supplied complete, fabricated and ready for installation. The piping shall be provided as shown on the drawings.

- B. Submittals. In addition to the requirements of Section 11001, shop drawings shall include the following:

1. Materials list and manufacturer's data
2. Detailed layout drawings

- C. Materials. All pipe and fittings will be manufactured to ASTM A778 from sheet and plate conforming to ASTM A-240, 316L. Finish to be No. 1 or better and as required by ASTM specs. Pipe in contact with 98% sulfuric acid shall be Alloy 20Cb-3, unless otherwise specified herein. Stainless steel pipe shall be as manufactured by Douglas Brothers, Portland, Maine, or approved equal.

1. Pipe and fittings up to 50 psi. operating pressure and maximum 300 Deg. F. will be supplied in the following nominal wall thicknesses:
 - a. 2 1/2" to 8" I.P.S. Schedule 10s
 - b. 10" and 12" I.P.S. Schedule 10s
 - c. 14" to 18" I.P.S. Schedule 10s
 - d. 20" I.P.S. Schedule 10s
 - e. 24" to 42" I.P.S. 1/4"
2. All elbows 24" and smaller shall be smooth flow (pressed type). All elbows greater than 24" diameter shall be mitered construction with at least (5) mitered sections for 90 Deg. bends and (3) mitered sections for 45 Deg. bends. Thicknesses for 316L stainless steel slip-on rolled angle face rings shall be equal to or greater than the pipe wall.

3. Backing flanges shall be of type 316L stainless steel and drilled to ANSI B16.1 Class 125 standard in the following thicknesses:
 - a. 2-1/2" thru 8" 1/2" thick
 - b. 10" - 14" 5/8" thick
 - c. 16" - 20" 3/4" thick
 - d. 24" - 30" 1" thick
 - e. 36" and larger 1-1/4" thick
 4. The rolled angle faces shall be true and perpendicular to the axis of the pipe or fitting. Plain ends of pipe or fittings shall be true and perpendicular to the axis with edges deburred. Bolts and nuts shall be 316L stainless steel.
 5. Pipe ends may be flanged as specified herein. Nipples shall be taper bored to the I.D. of the adjoining pipe to allow full weld penetration. Collars shall be welded on both sides to the piping. Nipples and collars shall be of the same alloy as the piping.
- D. Welding. Welding in fabricator's shop and in the field shall be performed by qualified welders to approved procedures. Welding rod or wire shall be of same composition or superior to the pipe and fittings material.
1. Weld deposit at the seams shall have a slight crown on both sides of the weld and no cracks or crevices shall be allowed.
 2. Excessive weld deposits, slag, weld spatter and projections into the interior of pipe shall be removed by grinding.
- E. Finish. Pipe and fittings shall be immersed in pickling solution in manufacturer's plant and scrubbed and washed until discoloration and possible iron, picked up from manufacturing process, is removed.
1. All field welds shall be treated with pickling paste, scrubbed and washed with stainless wire brushes until clean. Completed pipe lines shall be washed with steam or hot water to remove any dirt picked up during transport to the construction site.
 2. Particular care must be exercised during fabrication and installation to avoid contact of stainless steel pipe with structural steel, chain, wire-ropes, steel tools, etc., as the contamination of stainless steel by steel may lead to marks due to rusting of imbedded steel.
- F. Expansion Couplings. Provide mechanical couplings as shown on the drawings. Couplings shall be designed for use with 316L stainless steel air piping supplied under these specifications. Couplings shall allow up to one inch of pipe movement along the pipe axis (due to expansion and contraction). One end of the coupling shall be restrained, the other shall allow pipe movement. Couplings shall be Depend-O-Lok manufactured by Brico Industries, or approved equal.
- G. Installation Assistance. The Company shall provide a field technician experienced in installation of light-weight stainless steel pipe for a period of three man-days to assist and instruct the Company's forces in proper installation procedures. All bids shall include the cost for this service.
- H. Installation. Install in accordance with the manufacturer's recommendations and Section 11001.

2.05 STAINLESS STEEL PIPE, TUBING, AND FITTINGS (SS) - INSTRUMENT AIR

- A. Stainless steel tubing shall be Type 316 conforming to the requirements of ASTM Designation A269. Fittings shall be stainless steel compression type, Parker-Hannifin "Triple-Lock", Imperial-Eastman "High-Seal", Swage-Lok, or equal.
- B. For pipe sizes 2 inches and smaller.
 - 1. Pipes shall be Schedule 40 seamless stainless steel with threaded ends. They shall conform to material specifications ASTM A312-TP316 and dimensional specifications ANSI B-36.19.
 - 2. Fittings shall be threaded, 2,000 pound forged stainless steel. They shall conform to material specification ASTM A182-F316 and dimensional requirements of MSS Standard Practices SP49 and SP50.
- C. For pipes sizes 3 inches and larger.
 - 1. Pipes shall be, Schedule 40, unless otherwise stated, seamless stainless steel with bevelled ends for welding. They shall conform to material specification ASTM A312-TP316 and dimensional specification ANSI B-36.19.
 - 2. Fittings shall be, Schedule 40, unless otherwise stated, seamless stainless steel with bevelled ends for welding. They shall conform to material specification ASTM A403-WP316 and dimensional requirements of MSS Standard practice SP43P.
 - 3. Flanges shall be ANSI slip-on or welding neck type, with Class 150 rating. They shall conform to material specification ASTM A182-F316 and dimensional specifications ANSI B-16.5. When a stainless steel flange is connected to a cast iron, FRP or plastic flanged fitting or valve, the raised face of the stainless steel flange shall be removed.

2.06 GALVANIZED STEEL PIPE AND FITTINGS - 2½" AND SMALLER (GS)

- A. General. Galvanized steel pipe shall be seamless steel pipe conforming to ASTM A-53 standard weight. End finish shall be threaded, as indicated in the Schedule or shown on the drawings.
 - 1. Threaded ends. Conform to ANSI B1.20.1.
- B. Fittings and Joints.
 - 1. Threaded Fittings. Galvanized malleable iron conforming to ANSI B16.3; standard weight for standard weight pipe. Galvanized malleable iron fittings shall conform to ASTM A-47; galvanizing shall conform to ASTM A-153.
- C. Buried Galvanized Pipe. The exterior of buried galvanized pipe shall be primed and wrapped with a cold applied Type II tape, conforming to AWWA C209.
- D. Wall Thickness. Minimum allowable wall thickness, unless specified otherwise elsewhere, shall be as follows.

Pipe Diameter	Wall Thickness (Inches)
1/2"	0.109
1"	0.133
1 1/2"	0.145
2"	0.154
2 1/2"	0.203
3"	0.216

4"	0.237
5"	0.258
6"	0.280

2.07 DUCTILE IRON PIPE AND FITTINGS (DI)

A. Buried Mechanical Joint

1. Ductile Iron Pipe: Ductile iron pipe shall conform to the requirements of ANSI/AWWA C151/A21.51. Minimum Class 350 for pipe sizes 12" and smaller and Class 250 for larger pipe sizes, unless otherwise specified on the drawings. **All joints for buried ductile iron pipe shall be restrained, except as otherwise specified.** Buried pipe shall have an exterior 1 mil thick bituminous coating in accordance with AWWA C151. Pipe interior shall have a cement mortar lining seal coated in accordance with ANSI/AWWA C104/A21.4, standard thickness, unless otherwise noted. Buried pipe for use in gravity flow, raw sewage service shall be lined with virgin polyethylene complying with ANSI/ASTM D1248. Lining shall be minimum 30 mils thick.
2. Fittings: All ductile fittings shall be manufacturer's restrained joint or restrained mechanical joint with a minimum pressure rating of 250 psi, and shall conform to the requirements of ANSI/AWWA C110/A21.10 with the mechanical joint meeting the requirements of AWWA C111/A21.11, unless otherwise noted on drawings. All fittings shall be coated and lined as specified above for ductile iron pipe.
3. Restrained Joints: Restrained mechanical joints that require field welding or grooves cut in the pipe barrel for restraint will not be accepted. Restrained joints shall be furnished for pipe at changes in direction as shown on drawings. Restrained joints shall be a locked mechanical joint, and shall be American "Fast-Grip" for pipe sizes 4"-16", "Flex-Ring", for pipe sizes 20"-36" and "Lok-Ring" for pipe sizes larger than 36", or approved equal. Retainer glands shall not be allowed. Mega-lugs may be used on buried ductile iron mechanical joint fittings only when field adjustments are necessary. **Under no circumstances shall Mega-lugs be used on the plain end of fittings.** Straight run restraining required beyond fittings shall be manufacturers' restrained joints as specified above. All buried ductile iron piping shall be restrained unless otherwise specified on the drawings. American Field Flex-Ring is not acceptable.
4. Gaskets: Pipe and fitting gaskets conforming to ANSI/AWWA C111/A21.11, shall be of vulcanized crude rubber or polyvinyl chloride plastisol. Gaskets shall have plain tips unless otherwise specified. Lubricant shall be as supplied by manufacturer only (no substitutes) and shall be non-toxic or injurious to workers.
5. Bolts and Nuts: Bolts and nuts conforming to ANSI/AWWA C111/A21.11 shall be of high strength low alloy steel.
6. Weight and Class: The weight and class designation shall be painted in white on the exterior surface of all pipe and fittings. Manufacturer's code or serial numbers shall be provided on the bell of each pipe joint.
7. Polyethylene Tubing. Polyethylene tubing for buried ductile iron pipe encasement shall conform to the requirements of AWWA C105 and shall be 8 mil thick. Polyethylene tubing shall be installed on all buried ductile iron piping 16-inches in diameter and larger. Identification tape shall be secured over polyethylene tubing.

B. Exposed Joint

1. Pipe and Specials. Unless otherwise specified elsewhere exposed ductile iron pipe shall have flanged or grooved joints as shown on the drawings. Grooved end ductile iron pipe shall conform to AWWA C606 for rigid grooving dimensions. Flanged ductile iron pipe shall have a minimum wall thickness in accordance with Class 53 and shall conform to the requirements of ANSI/AWWA C115/A21.50 and AWWA/ANSI C110/A21.10, latest editions. Flanged pipe shall be rated for a working pressure of 250 psi. Flanges shall be ductile iron in accordance with AWWA C115 and drilled to ANSI B16.1 Class 125 dimensions. All flanged pipe shall be manufactured in the U.S.A.
2. Fittings. Fittings shall conform to the requirements of ANSI/AWWA C110/A21.10, 250 psi working pressure. Fittings shall be of the long radius type unless shown otherwise on the drawings.
3. Lining and Coating
 - a. Mortar Lining. Ductile iron pipe and fittings furnished for this project shall be cement mortar lined and seal coated per ANSI Specification A21.4 (AWWA C104), standard thickness.
 - b. Coatings. Exterior surfaces of exposed pipe shall be coated in accordance with Section 09905, "Painting and Protective Coatings."
4. Bolts and Nuts. Bolts and nuts shall be high strength low carbon steel conforming to ASTM A307, Grade B.
5. Gaskets. Gaskets shall be full face, 250 psi pressure rated SBR rubber.

2.08 CAST IRON SOIL PIPE (CI)

- A. Cast iron soil pipe shall be furnished and installed complete with all the fittings, joint accessories and necessary appurtenances. The pipe and fittings shall be either no-hub or hub and spigot type.
- B. Materials. All cast iron soil pipe, fittings and appurtenances, except where otherwise shown or specified shall conform to the following:
 1. Pipe and Fittings - ASTM A-74, Extra-Heavy
 2. Compression Gaskets - ASTM C564, 60 Hardness
- C. Joints
 1. General. Pipe cuts shall be made with approved mechanical cutters to produce clean cuts, perpendicular to the pipe.
 2. No-Hub. No-hub couplings shall be installed using a specially designed torque limiting wrench when tightening bands. No-hub couplings will be allowed only at changes in pipe material. Tightening bands shall be 316 stainless steel.

2.09 POLYVINYL CHLORIDE SCHEDULE PIPE AND FITTINGS (PVC-1)

- A. Pipe and fittings shall conform to the following requirements:
 1. Polyvinyl Chloride Pipe. Pipe shall conform to the requirements of ASTM Designation D1785, Schedule 80, designation 1120, and the fiber stress for deriving the short-time burst pressure requirement in accordance with Table 6, therein, shall not be less than 6,000 psi at 73.4 F. Pipe sizes 10" and larger shall conform to ASTM D2241 SDR26.

2. Polyvinyl chloride Pipe Fittings. Fittings shall conform to the requirements of ASTM Designation D2467, Class 12454-B for socket type, ASTM Designation D2464 for threaded type and ASTM D2241 for bell and spigot type.
3. Rigid, Unplasticized Compounds. Compounds for pipe fittings shall conform to the requirements of ASTM Designation D1784, Class 12454-B. For piping exposed to the sun, provide ultraviolet protection.
4. Joints in PVC Pipe and Fittings. Joints shall be the solvent-welded socket, flanged or push-on type as shown in the schedule. Flanges, where shown, shall be 150-pound, and shall be of the same material as the pipe. Bell and spigot joints shall utilize a retained ring gasket in accordance with ASTM D3139.
5. Bolts. Bolts for use with PVC flanges shall be stainless steel, Type 316.
6. Gaskets. Flange gaskets shall be a Teflon envelope with a high polymer chloride resin core. Gaskets for retained-ring bell and spigot piping shall be manufactured in accordance with ASTM F477.

2.10 POLYVINYL CHLORIDE GRAVITY SEWER PIPE AND FITTINGS (PVC-2)

- A. General. Pipe fittings and appurtenances shall be new, free from defects and shall be the standard product of the manufacturer. Unless otherwise indicated, sizes shall be nominal pipe diameter (inside dimension wall-to-wall).
- B. Material. Gravity Sewer PVC pipe and fittings shall be designed in accordance with ASTM D3034, and Uni-bell Plastic Pipe Association Standard PVC Plastic Gravity Sewer Pipe and Fittings (UI-B-4-82) as modified herein through 15 inches in diameter. For sizes above 15 inches in diameter, the pipe and fittings shall conform to ASTM F-679. Minimum pipe stiffness shall be 46 psi at 5 percent deflection, tested in accordance with ASTM D2412. The standard dimension ratio (SDR) shall equal 35.
- C. Pipe. Pipe shall meet or exceed the manufacturer's recommended minimum length. Pipe and fittings shall be homogeneous throughout and free from cracks, holes, foreign inclusions or other defects. The pipe and fittings shall be uniform in color, density, opacity and other physical properties. Pipe shall be color coded brown or green by the introduction of a pigment at the factory.
- D. Drop Impact Test. Pipe and fittings shall comply with the drop impact test by ASTM D2444.
- E. Joints. Gaskets shall meet the requirements of ASTM D3212. Pipe bells shall have the rubber ring installed in the bell groove at the factory. The joint shall provide a tight seal that will protect the pipeline from vibration, earth movement, shock, infiltration and compensate for expansion and contraction of the pipe.

2.11 THICKWALL POLYVINYL CHLORIDE PRESSURE PIPE AND FITTINGS (PVC-3)

- A. General. Pipe shall be of unplasticized polyvinyl chloride plastic class water pipe with integral bell and spigot joints for the conveyance of water and other fluids.
- B. Material. Pipe shall meet the requirements of AWWA C900. All pipe shall be Class 150 and shall meet the requirements of DR 18.

- C. Pipe. The pipe shall be suitable for use as a pressure conduit. The bell shall consist of an integral wall section with a solid cross-section elastomeric ring which meets the requirements of ASTM D-1869. The bell section shall be designed to be at least as strong as the pipe wall. A UV inhibitor shall be added during the manufacturing process to retard color changes to blue.

1. All PVC-3 potable water piping shall be blue in color via the addition of a pigment at the factory.

- D. Quick Burst Test. Randomly selected samples tested in accordance with ASTM D-1599 shall withstand without failure a pressure of 755 psi at 73°F. applied in 60-70 seconds. Rubber-ring-seal test jigs shall be used.

- E. Joints. The push-on joint with the flexible elastomeric ring shall provide a tight seal that will protect the line from vibration, earth movement, shock, and shall compensate for the expansion and contraction of the pipe. Restrained joints shall be Uni-Flange series 1350 for PVC-PVC joints and uni-Flange series 1300 for PVC-Cast Iron Valve Joints. **All buried PVC-3 piping shall be restrained unless shown otherwise on the DRAWINGS.**

- F. Fittings. Fittings shall be ductile iron mechanical joint bell fittings conforming to par. 2.08 of this section. All penetrations for PVC pipe shall require a tapping saddle. Direct taps will not be allowed.

- G. Drop Impact Test. Pipe shall withstand without failure at 73°F, a 120 foot pound impact of a falling 12-lb. missile with a 2-inch radius nose. (As per ASTM D 2444)

1. There shall be no visible evidence of shattering or splitting when the energy is imposed.

2.12 POLYVINYL CHLORIDE PERFORATED PIPE (PVC-4)

- A. Pipe shall conform to the requirements of PVC-2 pipe, but shall be perforated in accordance with ASTM C-508.

2.13 CHLORINATED POLYVINYL CHLORIDE (CPVC)

- A. Chlorinated polyvinyl pipe shall be of unplasticized compounds suitable for use with potable water as shown and as specified and shall bear the seal of approval to this effect from an accredited testing laboratory. Pipe shall conform to the requirements of ASTM designation D2846. Fittings shall conform to the requirements of ASTM designation D2846, CPVC41. Compounds for pipe fittings shall conform to the requirements of ASTM designation D1784, Class 23447-B. Joints shall be solvent-welded socket type.

2.14 CHLORINATED POLYVINYLCHLORIDE (CPVC) OR NON-CHLORINATED POLYVINYLCHLORIDE (PVC) SCHEDULE 80 DOUBLE CONTAINMENT PIPING SYSTEM

- A. General. Each contained piping system shall consist of schedule 80 CPVC/PVC primary piping system supported within a schedule 80 CPVC/PVC secondary containment housing. Carrier fitting sizes 1/2" through 8" will utilize supports minimizing the number of carrier fitting joints. Each system shall be provided with suitable drains and vents and be designed to provide complete drainage of the secondary containment piping. Interstitial supporting devices shall be provided within the secondary containment pipe, and shall be designed to allow continuous drainage in the annular space to the drain points. Drain fittings shall be designed to allow a valve attachment to be

be made so that the secondary containment compartment may be readily drained and manually checked for leaks.

B. Materials

1. The primary pipe and containments shall be schedule 80 materials. Pipe shall have schedule 80 CPVC pipe thickness and meet ASTM D-1784 Type 4, Grade 1 and ASTM F-441. PVC pipe shall have the same requirements as Schedule 80 PVC in Paragraph 2.10. All listed pressure fittings shall be schedule 80 CPVC according to ASTM F-439. All other unlisted components that are intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent schedule 80 CPVC/PVC pipe.
2. Interstitial supporting devices used to center and support the primary piping within the secondary containment piping shall be manufactured from the same resin as the product pipe.
3. The secondary containment pipe and components shall be schedule 80 materials. Pipe shall have schedule 80 CPVC thickness according to ASTM D-1784, Type 4, Grade 1. PVC pipe shall have the same requirements as Schedule 80 PVC in Paragraph 2.10. All listed pressure fittings shall be schedule 80 according to ASTM F-439. All other unlisted components that are intended for use as pressure retaining components shall have sufficient thickness and reinforcement so as to be able to maintain the same pressure ratings as the equivalent schedule 80 CPVC pipe.
4. All fittings shall be pre-assembled and pre-tested by the manufacturer.

C. Vents. High-point vents shall provide adequate flows to completely drain annular space. Vents shall be located at high points or per drawings. Vents shall be of same resin as secondary containment pipe.

D. Leak Detection. At low points or as shown on the drawings, provide at each zone a density sensor station consisting of an external clip-on sensor, drip leg and drain valve and/or riser and sensor extension handle. Each sensor shall have LED testing lamp, adjusting potentiometer and be removable for periodic testing. Sensor shall not penetrate the containment piping jacket. Control console shall be housed in a NEMA IV enclosure, operating on 120 VAC and supplies 24 VDC to zone sensors. Console shall have ten zone capacity, alarm lamps, and mute switch. Console shall also have a common audible alarm. Manufactured by GUARDIAN SYSTEMS, MI, Div. of Eslon Thermoplastics, Asahi, or approved equivalent. Refer to Division 13 and 16.

2.15 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

A. HDPE pipe and fittings shall be a PE3408 high density, extra-high molecular weight polyethylene manufactured from first-quality high density polyethylene resin containing no additives, fillers, or extenders. The HDPE pipe shall have an ASTM D3350 cell classification of PE 345434C, and shall meet or exceed the properties listed in Table 02618-1 of this specification. The HDPE pipe and fittings shall be SDR-11 Phillips Driscopipe Series 1000, Chevron Plexco, or approved equal, and shall bear the approval seal of the National Sanitation Foundation (NSF).

B. Joints: A continuous pipe shall be formed by butt fusing sections of pipe using manufacturer-approved equipment. The fused joints shall have equal or greater tensile and hydrostatic strength than the pipe.

2.16 SUPER DUPLEX 20 (SD20) PIPE

Pipe and fittings shall conform to the following requirements:

- A. Super Duplex 20 pipe and fittings shall be ASTM A790/A 790M UNS S32750 welded pipe. The pipe and fittings shall be by Ocean International Suppliers or approved equal.
- B. Joints: The pipe shall be made by an automatic welding process, with no addition of filler metal in the welding process using manufacturer-approved equipment. The welded joints shall have equal or greater tensile and hydrostatic strength than the pipe.

2.17 GLASS-FIBER-REINFORCED THERMOSETTING-RESIN PRESSURE PIPE (FRP2)

- A. Pipe shall be fabricated and factory-tested in accordance with the requirements of AWWA C950, Type I, Grade 2 - Class 50 and ASTM D-2996.
- B. Raw materials shall conform to the following standards:

Tensile properties of glass fibers	ASTM D-2343
Moisture content of resin	ASTM E-203
Viscosity of resin	ASTM D-2393
	ASTM D-445
Acid number of resin	ASTM D-1639
- C. Flanged Connections. Flanges shall be constructed by the hand lay-up method and drilled in accordance with ANSI B16.1 applicable to 125 lb. cast iron flanges. Flanged connections shall be constructed to resist the combined forces of the end load plus the internal pressure resulting from the service conditions encountered.

2.18 HALAR E-CTFE PIPING

- A. General
 - 1. System shall be a Halar E-CTFE system of uniform pipe and fitting resin. System pressure ratings shall be based on continuous use of 50 years. Pipe and Fittings shall be based on a Standard Dimensional Ratio (SDR) of 21, 1/2" through 4" (20-110mm). Pressure rating for pipe and fittings shall be 150 psi (10 bar) for sizes up to 1 1/2" and 120 psi (8.3 bar) for sizes 2" (63mm) and above. When applicable, a double containment piping system of uniform materials and pressure rating shall consist of primary pipe of Halar E-CTFE and secondary pipe shall be polypropylene.
 - 2. Manufacturers. Subject to compliance with requirements, products that may be incorporated in the work include Ultra Proline Halar E-CTFE Piping by Asahi/America, Inc. of Malden, Massachusetts, 1-800-343-3618. Manufacturer shall be ISO 9001 certified, or approved equal.
- B. Material
 - 1. Primary Pipe: Wetted surfaces shall meet the requirements as defined herein.
 - a. Pipe, valves and fittings shall be made from Halar resin produced by Solvay. MFI shall be 3.0 – 6.0 g/10min per 275/2.16 according to ASTM D 792.
 - b. All resins shall not introduce contaminations into the designed system. Specifically, all raw materials in product manufacturing shall be free of chemical additives, fillers,

property enhancers and reinforcements, such as antioxidants, anti static agents, colorants, flame retardants, heat stabilizers lubricants, mold release agents, pigments, plasticizers, processing aids, ultraviolet stabilizers and viscosity depressants.

- c. In addition, manufacturer shall test all lots to ensure the melt flow index is within allowable range.
2. Secondary Pipe: When applicable, pipe shall meet the requirements for a polypropylene material according to ASTM D 4101-86. Post extrusion annealing will not be allowed.

C. Pressure Rating Pipes and Specialty Fittings. All fittings, unless otherwise noted, shall meet requirements in Section A. Specialty fittings are to include restraint fittings, butt fusion instrumentation fittings, instrumentation donuts, etc. Specialty fittings shall be machined or molded of the same E-CTFE resin as the pipe and fittings.

D. Valves. All valves shall be produced in the same manner as E-CTFE Fittings, using Solvay resins.

E. Joining Equipment. Ultra Proline installation shall be performed by factory certified and trained installers in accordance with manufacturer's ISO procedures and ASTM D 2657. Date of certification or re-certification shall not exceed one year from the beginning of project. A continuous pipe shall be formed by butt-fusion or non-contact butt-fusion.

2.19 POLYVINYLIDENE FLUORIDE (PVDF) DOUBLE CONTAINMENT PIPING SYSTEM

A. General

1. System shall be a double-containment piping system of uniform materials. Primary pipe shall be capable of transporting media under continuous exposure for 50 years. Secondary pipe shall be capable of transporting stated media, in the event of failure of product pipe, for 50 years.
2. System shall provide ability to incorporate leak detection as specified in the Test Procedures Section. Access tees, pull ropes, and low point instrumentation taps shall be provided as specified by leak detection vendor and/or drawings.
3. System shall provide full containment of all accessories such as floor drains, cleanouts, valves and tanks, etc.
4. Manufacturers. Subject to compliance with requirements, products that may be incorporated in the work include Duo-Pro by Asahi/America, Inc. of Malden, Massachusetts, 1-800-343-3618. Manufacturer shall be ISO 9001 certified, or approved equal.

B. Materials

1. Primary Pipe: Pipe and fittings shall meet the requirements for a polyvinylidene fluoride resin according to ASTM D 3222. Post extrusion annealing will not be allowed. All related accessories, pipe supports, anchors, welding rod, etc. shall be made from the same resin.
2. Secondary Pipe: Pipe and fittings shall meet the requirements of Paragraph 1 above.

C. Pressure Rating Pipes and Fittings. Both inner and outer pipes and fittings shall conform to requirements for establishing a hydrostatic design basis.

1. Primary Pipe and Fittings. The product pipe and fittings shall be sized per SDR standards for a pressure rating of 230 psi at 68° F for all diameter sizes 1/2" – 2 1/2" and 150 psi for all diameters sizes 3" – 12".

2. Secondary Pipe and Fittings. The secondary pipe and fittings shall have a standard dimensional ratio of SDR-11 and shall be pressure rated to 150 psi for all diameter sizes 1/2" – 18". No split fittings will be allowed.
- D. Unlisted Components. Any special fittings, welded areas, etc. not supplied as part of the normal product offering shall be classified as unlisted components. Products falling into this category shall be pre-tested to twice the maximum operating pressure for a period of 2 hours minimum.
- E. Valves. Valving arrangements that are to be double contained shall be supplied pre-assembled and tested to 150% of maximum operating pressures. Actuators, stem extensions, and other accessories shall be part of a pre-assembled package where appropriate.
- F. Pipe Supports. Supports, guides, etc. for product pipe shall be provided of the same resin as product pipe. Supports shall be placed in a manner that a maximum of 0.1" deflection is allowed between supports. Supports shall allow axial movement of product pipe within containment pipe. Supports shall maintain a concentric relation between product pipe and containment pipe. Supports shall supply a minimum of 1.5" wide surface area to prevent point loading of product pipe.
- G. Anchors. Anchors shall be provided of same resin as product pipe and containment pipe. Anchors shall be of same wall thickness as product and containment pipe. Anchors shall be fully pressure rated.
- H. Simultaneous Weld Discs. Simultaneous weld discs shall be provided of same resin as product pipe and containment pipe. Simultaneous weld discs shall supply 4 openings on 90° spacings to allow for drainage and venting of the annular space. Simultaneous weld discs shall be sized to maintain alignment of product pipe within $\pm 10\%$ of wall thickness.
- I. Vents. High-point vents shall provide adequate flows to completely drain annular space. Vents shall be located at high points or per drawings. Vents shall be of same resin as secondary containment pipe.
- J. Leak Detection. At low points or as shown on the drawings, provide a density sensor station consisting of an external clip-on sensor, drip leg and drain valve and/or riser and sensor extension handle. Each sensor shall have LED testing lamp, adjusting potentiometer and be removable for periodic testing. Sensor shall not penetrate the containment piping jacket. Control console shall be housed in a NEMA IV enclosure, operating on 120 VAC and supplies 24 VDC to zone sensors. Console shall have ten zone capacity, alarm lamps, and mute switch. Console shall also have a common audible alarm manufactured by GUARDIAN SYSTEMS, MI, Div. of Eslon Thermoplastics, Asahi, or approved equivalent. Refer to Division 13 and 16.

2.20 POLYPROPYLENE DOUBLE CONTAINEMENT PIPING SYSTEM

A. General

1. System shall be a double-containment piping system of uniform materials and pressure rating as specified below. System product pipe shall be capable of transporting stated media under continuous exposure for 50 years. System containment pipe shall be capable of transporting stated media, in the event of failure of product pipe, for 50 years.

2. System shall provide the ability to incorporate leak detection as specified within the Leak Detection Section. Access tees, pull ropes, and low-point instrumentation taps shall be provided as specified by leak detection vendor and/or contract drawings.
 3. System shall provide full containment of all accessories such as floor drains, cleanouts, valves and tanks, etc.
 4. Manufacturers. Subject to compliance with requirements, products that may be incorporated in the work include Duo-Pro by Asahi/America, Inc. of Malden, Massachusetts, 1-800-343-3618. Manufacturer shall be ISO 9001 certified, or approved equal.
- B. Materials
1. Primary Pipe: Pipe and fittings shall meet the requirements for a polypropylene material according to ASTM D 4101-86. Post extrusion annealing will not be allowed.
 2. Secondary Pipe: Pipe and fittings shall meet the requirements of Paragraph 1 above.
- C. Pressure Rating Pipes and Fittings. Both inner and outer pipes and fittings shall conform to requirements for establishing a hydrostatic design basis.
1. Primary Pipe and Fittings. The product pipe shall have a standard dimensional ratio of SDR-11 and shall be pressure rated to 150 psi at 68oF for all diameter sizes ½”-16”.
Alternative: The product pipe shall have a standard dimensional ratio of SDR-32 and shall be pressure rated to 45 psi at 68oF for all diameters 4”-24”.
 2. Secondary Pipe and Fittings. The containment pipe shall have a standard dimensional ratio of SDR-32 and shall be pressure rated to 45 psi for all diameters 4”-24”.
Alternative: The containment pipe shall have a standard dimensional ratio of SDR-11 and shall be pressure rated to 150 psi at 68oF for all diameters ½”-18”.
- D. Unlisted Components. Any special fittings, welded areas, etc. not supplied as part of the normal product offering shall be classified as unlisted components. Products falling into this category shall be pre-tested to twice the maximum operating pressure for a period of 2 hours minimum.
- E. Valves. Valving arrangements that are to be double contained shall be supplied pre-assembled and tested to 150% of maximum operating pressures. Actuators, stem extensions, and other accessories shall be part of a pre-assembled package where appropriate.
- F. Pipe Supports. Supports, guides, etc. for product pipe shall be provided of same resin as product pipe. Supports shall be placed in a manner that a maximum of 0.1” deflection is allowed between supports. Supports shall allow axial movement of product pipe within containment pipe. Supports shall maintain a concentric relationship between product pipe and containment pipe. Supports shall supply a minimum of 1.5” wide surface area to prevent point loading of product pipe.
- G. Anchors. Anchors shall be provided of same resin as product pipe and containment pipe. Anchors shall be of same wall thickness as product and containment pipe, and be of unitary construction. Anchors shall be fully pressure rated.
- H. Simultaneous Weld Discs. Simultaneous weld discs shall be provided of same resin as product pipe and containment pipe. Simultaneous weld discs shall supply 4 openings on 90° spacings to allow for drainage and venting of the annular space. Fabricated simultaneous weld discs shall be designed with vent and drain openings. Simultaneous weld discs shall be sized to maintain alignment of product pipe within ±10% of wall thickness.

- I. Vents/Drains. High-point vents and low-point drains shall provide adequate flows to completely drain annular space. Vents/drains shall be located per contract drawings. Vents/drains shall be of same resin as product pipe.
- K. Access Tees. Shall be provided per contract drawings and per leak detection manufacturer's requirements. Access tees shall be of same resin as pipe.
- L. Double Contained Flanges. All double contained flange connection shall consist of a double o-ring flange and a flat faced flange. The flange design shall provide adequate flow of fluid through the annular space. All flanges shall be of the same resin as the pipe and shall have a 50-psi pressure rating at ambient temperature.

2.21 REINFORCED CONCRETE PIPE (RCP)

- A. Pipe. Reinforced concrete pipe shall be designed, manufactured, tested, and inspected in accordance with ASTM Standard C76 Class IV except as further noted in these specifications. Joints shall be in accordance with ASTM C443. Compressive strength of the concrete shall not be less than 2,300 psi at seven (7) days and 4,500 psi at twenty-eight (28) days. Portland cement shall conform to the requirements of ASTM C150, Type II. Pipe sections shall be made in minimum lengths of eight (8) feet, except where shorter lengths are required to meet special conditions. Maximum length shall be twenty (20) feet. The pipe wall shall have a minimum of 3/4-inches of concrete between the reinforcing steel and the inside diameter.
- B. Joints. Joints shall be of the bell and spigot type, with one or two neoprene rubber gaskets. The joints shall be designed so that the spigot will readily enter the bell of the pipe, and the shape and dimension of the joint shall be such that it will be self-centering upon closure. The joint shall be so designed that the gasket shall not be required to support the weight of the pipe but shall keep the joint tight under all normal earth settlement. Joints shall conform to the requirements of AWWA Standard C302, Paragraph 3.3.
- C. Gaskets. Gaskets shall conform to paragraph 3.4 of AWWA Standard C302 except as otherwise noted below. The gasket shall contain not less than fifty (50) percent by volume of neoprene and shall contain no improper mixing compound, reclaimed rubber, or any deleterious substance. All gaskets shall be extruded or molded and cured in such a manner that any cross section will be dense, homogeneous, and free from porosity, blisters, pitting and other imperfections. The gaskets shall be extruded or molded with smooth surfaces to the required diameter as recommended by the pipe manufacturer within a tolerance of plus or minus one-sixty-fourth (1/64) of an inch.
- D. Markings. The following shall be clearly stenciled on each pipe section:
 - 1. Design Load Strength.
 - 2. Internal Diameter, in inches.
 - 3. Name of Manufacturer.
 - 4. Date of Manufacture.
 - 5. Letter "T" six (6) inches or more from the end of the pipe to indicate the top of pipe for correct installation when elliptical reinforcing is used.

2.22 CORRUGATED METAL PIPE (CMP)

- A. Pipe. Corrugated metal pipe shall be galvanized steel conforming to AASHTO M-36 having a minimum 12 gauge thickness with a corrugation pitch/depth of 3-inches x 1-inch or 2-2/3 inches x

1/2-inch. Pipe and couplings shall have full interior and exterior bituminous coating conforming to AASHTO M-190.

- B. Coupling Bands. Coupling bands shall be of the same material as the pipe and shall conform to the referenced standards.

2.23 COMPRESSED AIR PIPING

- A. General. System shall be produced of PE100 uniform pipe and fitting materials. System pressure ratings shall be based on continuous use of 50 years. Material must be colored coded blue for identification.
- B. Materials
 - 1. General: Pipe, valves and fittings shall be made from virgin resin produced by one supplier. The resin shall be PE100, Solvay Eltex TUB 124 blue high density polyethylene material according to ASTM D-3035.
 - 2. Chemical Resistance and application of Air-Pro to be verified and approved by manufacturer.
 - 3. Engineering and Design criteria should be per Manufacturer's printed literature.
 - 4. All pipe systems shall have been tested for and meet the safety requirement of Cal OSHA thermoplastic pressure vessels for compressed air piping.
- B. Pipe. All pipe through 4" shall be extruded from PE100 resin as outlined herein. All piping is produced based on an SDR system and calculated utilizing a Hydrostatic Design Basis according to ASTM D 2837. Pipe shall have a pressure rating of 230 psi in all sizes.
- C. Fittings. All fittings shall be injected molded. Fittings shall have same wall thickness and pressure rating as the pipe. Fittings shall be socket fusion style in 1/2' – 4" and butt fusion in 6" and above. Pipe and fittings shall be 230 psi rate at 68°F.
- D. Valves. All valves shall be produced in the same manner as the fittings.
- E. Joining Equipment. All fittings shall be pre-qualified through training on welding techniques according to ASTM D 2657. A continuous pipe shall be formed by socket fusion for 1/2"- 4" and butt-fusion for 6" and larger.

2.24 PIPING INSULATION AND LAGGING

- A. Pipe insulation shall be 2 inches thick rigid fiberglass as manufactured by Owens Corning Fiberglass, or approved equal. Insulation not exposed to weather shall be lagged with white kraft paper bonded to aluminum foil, reinforced with fiber glass yarn, suitable for painting. Insulation exposed to weather shall be lagged with factory applied .016 inch thick aluminum. Fittings shall be insulated with factory precut inserts covered with a premolded jacket. Pipe insulation is required on all exposed NaOH piping in accordance with Section 11240.
- B. Insulation shall have composite (insulation, lagging and adhesive used to adhere the jacket to the insulation) Fire and Smoke Hazard ratings as tested under procedure ASTM E84, NFPA 255, and UL 723, not exceeding:
 - 1. Flame Spread 25
 - 2. Smoke Developed 50

- C. Accessories such as adhesives, mastics, cements and cloth for fittings shall have the same component ratings as listed above.
- D. Paper laminate jackets shall be permanently fire and smoke resistant. Chemicals used for treating paper in jacket laminates shall not be water soluble and shall be unaffected by water and humidity.

2.25 MECHANICAL COUPLINGS

- A. Flexible Couplings. Flexible (sleeve) couplings shall be of the full sleeve type, split sleeve type, or flanged adaptor type, as shown on the drawings, specified herein, or as otherwise permitted by the City Engineer. They shall provide the requisite pipe flexibility without jeopardizing pipe joint integrity because of hydraulic thrust, and shall have the same pressure-rating as the pipe. Couplings shall have all metal bearing surfaces and shall be provided with carbon steel bolts and nuts. Flexible couplings shall be restrained unless the City Engineer has given his approval to omit this feature for specific cases.
 - 1. Full Sleeve Type Couplings shall be properly gasketed and shall be of a diameter to fit the pipe. Each coupling shall consist of a steel middle ring, 2 steel followers, 2 gaskets, and the necessary steel bolts and nuts to compress the gaskets. The couplings shall be Dresser Style 38, Smith Blair Type 411, or approved equal. Couplings to be installed underground shall have a hot-dipped galvanized sleeve and bolts.
 - 2. Flexible Flanged Coupling Adaptors shall be of the sleeve type, consisting of steel middle ring, steel followers, gaskets and steel bolts and nuts to compress the gaskets. The couplings shall contain anchor studs of strength adequate to hold the pipe together under a pull equal to the longitudinal strength of the pipe at a tensile stress of 20,000 psi, and shall be Smith-Blair No. 913, Dresser Style 128, or equal. Couplings to be installed underground shall have a hot-dipped galvanized sleeve and galvanized bolts.

2.26 WALL/FLOOR SLEEVES (DRY INSTALLATIONS)

- A. Wall sleeves to be installed in dry interior walls shall be Schedule 40 galvanized steel pipe and shall conform to the detail shown on the drawings. Wall sleeves with invert elevations more than 12" above normal maximum water surface elevations shall be considered dry installations.
- B. Wall sleeves shall be fabricated from Schedule 40 galvanized steel pipe and shall have a steel annular ring welded to the middle of the pipe. The ring shall be secured to the barrel by continuous welds on both sides of the ring. After fabrication the sleeve and ring shall be hot-dip galvanized.

2.27 WALL/FLOOR SLEEVES (WET INSTALLATIONS)

- A. Wall/floor sleeves for pipe up to 54-inches in diameter shall be ductile iron castings constructed with wall thickness and lining equivalent to the attached pipe, except in no case shall the wall thickness be less than 0.1345-inch. The casting shall incorporate a water stop/thrust reaction ring cast onto the barrel. The ring shall have a minimum width of 7/8-inch and a minimum thickness of 1/4-inch for 4" and smaller barrel size, increasing uniformly to 3-inches minimum width and 1/2-inch minimum thickness for 54-inch barrel size. End configurations shall be as shown on the drawings.
- B. Wall/floor sleeves for pipe over 54-inches in diameter shall be fabricated from carbon steel manufactured in accordance with AWWA C200, ASTM A283, Grade D having a minimum

accepted yield strength of 33,000 psi and a minimum wall thickness of 1/4-inch. The sleeve shall incorporate a water stop/reaction ring continuous welded on both sides of the barrel. The ring shall have a minimum width of 6-inches and a minimum thickness of 3/4-inch. End configuration shall be as shown on the drawings.

- C. Coat all in accordance with Section 09905.

2.28 PIPE HANGERS AND SUPPORTS

- A. Pipe hangers, brackets, saddles, clamps, and other supports shall be adjustable type conforming to the requirements of ANSI B31.1, Section 6; shall have ample strength and rigidity to resist the hydraulic thrusts at changes in direction and at dead ends as well as the dead weight loads and the load carried. Where not specifically identified or called out on the drawings, computations showing adequacy of Company selected hangers and supports to meet these requirements shall be submitted with the Shop Drawings. Hangers and supports so identified on the drawings does not relieve the Company from meeting all requirements specified herein. Wherever possible, brackets shall be used in lieu of hangers.
- B. General. Hangers and supports shall include all hanging and supporting devices of metallic construction shown, specified, or required for pipe lines, apparatus, and equipment other than electrical equipment. The Company 's working drawings, as required herein, shall show the quantity, type, design, and location of all hangers and supports required under the various Service Contract items. Hangers and supports shall be painted the same as required for the supported piping.
 - 1. Unless otherwise specified or shown, bolts, stud bolts, rods, yokes, and nuts of hangers and supports shall be 316 stainless steel. Bolts shall not be less than 1/2-inch diameter unless otherwise called for on the drawings.
 - 2. Except where otherwise shown, specified, or required, hangers, supports, anchors and concrete inserts shall be the standard types as manufactured by Elcen Co., Grinnell Co., Fee and Mason Manufacturing Co., or equal meeting the requirements specified herein. Unless otherwise approved by the City Engineer, all hangers, supports, and concrete inserts shall be listed with the Underwriters' Laboratory.
 - 3. Fiberglass reinforced plastic (FRP) pipe shall be supported at such limits as to assure that deflection is no greater than L/180 where L is the distance between supports.
- C. Design. Hangers and supports shall be adequate to maintain the pipe lines, apparatus, and equipment in proper position and alignment under all operating conditions. Hangers and supports shall be of standard design where possible, and be best suited for the service required, as approved by the City Engineer. Where required, they shall be screw adjustable after installation. Supporting devices shall be designed in accordance with the best practice and shall not be unnecessarily heavy. Sufficient hangers and supports shall be installed to provide a working safety factor of not less than 4 for each hanger, assuming that the hanger is supporting 12 feet of pipe filled with water. On pipes 3 inches in diameter and larger which are covered with insulation, hangers and supports shall include proper pipe protection saddles.
 - 1. Hangers and supports shall be designed and selected in accordance with MSS Standard Practices: SP-58, Pipe Hangers and Supports - Materials and Design; and SP-69, Pipe Hangers and Supports - Selection and Application.

- D. Supports for FRP and PVC Piping. Rigid plastic piping normally shall be supported by the same type of hangers used with steel pipe, except that in no instance will C-clamp, or other point-bearing supports be allowed. Riser clamps, if required, shall be full-circumferential type only. Support spacing shall be based on the plastic pipe manufacturer's recommendations for the service conditions. Flexible plastic tubing or rigid plastic pipe operating at temperatures high enough to lower its strength, shall be supported continuously by light metallic angles or channels and special hangers.
- E. Saddle Stands. Saddle stands shall be of adjustable type. Each stand shall consist of a length of wrought pipe fitted at the base with a standard screw threaded cast iron flange and at the top with an adjustable saddle or roll. The base flange shall be bolted to the floor or foundation. Stanchions shall be of similar construction to the saddle stand, except that they shall be fitted at the top with cast iron pipe saddle supports or with pipe stanchion saddles with yokes and nuts. Where adjustable supporting devices are not required, pipe lines 3 inches in diameter and smaller may be supported on approved cast iron, malleable iron, or wrought steel hooks, hook plates, ring or ring plates.
- F. Anchors. Anchors shall be furnished and installed where specified, shown, or required for holding the pipe lines and equipment in position or alignment. Anchors shall be designed for rigid fastening to the structures, either directly or through brackets. The design of all anchors shall be subject to approval by the City Engineer.
- G. Materials. No use shall be made of wire, straps, chains, etc., for supporting piping. Hangers and supports of metallic construction shall conform to the requirements of Section 05500.
- H. Supports for Piping. Brackets for support of piping from walls and columns shall be made of galvanized steel unless otherwise specified. When brackets are bolted to walls, back plates of adequate size and thickness shall be furnished and installed to distribute the load against the wall. Pipe rolls or chairs shall be of the cast iron type. Pipe rolls shall be provided with threaded rods.
- I. Spacing of Hangers. Pipe support spacing requirements are indicated on the drawings or elsewhere in these specifications, but in no case shall the spacing of hangers exceed the following:

MAXIMUM UNSUPPORTED PIPE SPAN
(FEET)

Nominal Pipe Size-Inches	Ductile Iron	Steel	PVC Max. Temp. 130° F	FRP
			Sch. 80	
1/2	-	5	3.5	---
3/4	-	6	3.5	---
1	-	7	3.8	3
1-1/4	-	7	4.0	---
1-1/2	-	9	4.0	4
2	-	10	4.33	5.25
2-1/2	-	11	4.75	---
3	-	12	5.0	7.5
3-1/2	-	13	5.0	---
4	8	14	5.25	8.5
5	10	---	---	---
6	10	16	10	10
8	10	16	11	11
10	10	17	12	12
12	12	17	12	12
14	12	19	12	12
16	12	19	12	12
18	14	19	12	12
20	14	20	12	12
24	14	23	12	12
30	14	23	12	12
36	14	23	12	12
42	14	23	12	12
48	14	23	12	12

- J. Where concentrations of valves, fittings, and equipment occur, closer spacing of supports will be required. In no case shall any total hanger load (weight of piping, insulation, and contents) exceed the following load carrying capacities for hot rolled steel rod ASTM A36-77a):

Nominal Rod <u>Diameter - Inches</u>	Maximum Safe Load - Pounds <u>Max. Temp. 650° F</u>
1/2	1,130
5/8	1,810
3/4	2,710
7/8	3,770
1	4,960
1-1/8	6,230
1-1/4	8,000
1-3/8	9,470
1-1/2	11,630
2	20,700

- K. Support of Vertical Pipes. Where vertical pipe runs exceed 15 feet, and a support system is not indicated on the drawings, provide carbon steel riser clamps for support and steadying of the pipe. Where possible, riser clamps shall be fitted and bolted below a coupling, flange, or hub. Maximum spacing of clamps shall be 15 feet.
- L. Unsupported lengths of tubing in excess of the lengths presented in par. H. above shall be continuously supported utilizing a 316 S.S. support track similar to Channel-Track #SS400C200-4 with single line clamps.

2.29 PIPE SLEEVE SEALING MATERIALS

- A. Pipe Sleeve Sealant. Pipe sleeve sealants shall be as shown on the drawings and shall conform to the requirements of Section 07900 unless otherwise specified.
- B. Modular Wall Seal. Where indicated on the drawings or approved by the City Engineer, a modular wall seal shall be furnished and installed.
 - 1. Seals. Seals shall be modular mechanical type consisting of interlocking solid synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Links shall be loosely assembled with bolts to form a continuous rubber belt around the pipe with a pressure plate under each bolt head and nut. After the seal assembly is positioned in the sleeve, tightening of the bolts shall cause the rubber sealing elements to expand and provide an absolutely water-tight seal between the pipe and the wall opening, capable of, and guaranteed to be water-tight with up to forty (40) feet of hydrostatic pressure differential. The seal shall be constructed to provide dielectric insulation between the pipe and the wall opening. Seals for compressed air piping installations shall be rated for high temperature service (+450°F). Modular wall seal shall be Link-Seal or approved equal.
 - 2. Wall Opening. The Company shall provide the wall opening sized as recommended by the seal manufacturer to assure a water-tight joint. The wall opening casing shall be galvanized steel wall sleeve as specified in par. 2.22.
 - 3. Materials.
 - a. Rubber Links. EPDM synthetic rubber, ASTM D-1418.
 - b. Pressure Plate. Delrin plastic.
 - c. Bolts and Nuts. Stainless Steel, type 316.
 - 4. Submittal. The Company shall submit marked manufacturer's catalog cuts and materials information for each modular wall seal in accordance with these specifications.

2.30 MISCELLANEOUS VENTS/AIR INLETS

- A. All vents and air inlet piping shown on the drawings shall be equipped with 304 S.S./18 x 18 mesh screens secured between two open flanges. Flanges shall be of the same material as the vent piping.

2.31 EXPANSION JOINTS

- A. Expansion joints shall be series 501 as manufactured by Mercer Rubber Company, Hauppauge, NY, or series 231 Proco Products, Inc., Stockton, CA or approved equal.
- B. Joint components shall consist of a cover, structural carcass, and tube.

- C. Covers shall be a minimum 1/8-inch thick natural-rubber compound.
- D. The carcass shall consist of a minimum of four plies of rubber impregnated Nylon tire cord backed up by steel wire or hoops.
- E. The tube shall be a minimum 1/4-inch thick natural-rubber compound. Abrasive resistance must be verified by test, ASTM-D394-46 and the material must be capable of withstanding the temperature, corrosive and abrasive properties of potable water. These capabilities shall be documented by the expansion joint manufacturer by test reports, recommendations of the elastomer supplier or an independent laboratory.
- F. Expansion joints shall be capable of meeting the following movement requirements; compression 1.25-inches, extension 0.75-inches, lateral 0.625-inches, angular 2 degrees, and torsion 1 degree.
- G. The laying length of the 24-inch expansion joints shall be 10-inches.
- H. Rated working pressure shall be 160 psi, minimum burst pressure shall be 280 psi, and vacuum shall be 30 inches of mercury.
- I. Expansion joints shall be steam cured at a minimum of 50 psi.
- J. Backup rings for the flange attachments shall be ductile iron 1-1/8-inches thick.
- K. The expansion joint manufacturer shall provide a set of calculations that will verify the structural carcass integrity. The calculations shall include the fabric reinforcement bias angle in the arch and body of the expansion joint, swell and expansion due to the operating pressures and the maximum stress on the fabric reinforcement. Calculations shall include the hoop stress in the arch rings and wire reinforcement.
- L. All calculations for the structural carcass shall demonstrate a 3/1-safety factor on all components and materials. A registered engineer with 3 years of documented elastomeric joint design experience shall stamp calculations.

2.32 PIPE MATERIAL SCHEDULE

- A. The pipe material schedule is presented as Table 1. Pipe shall be as indicated in the schedule unless otherwise shown on the drawings or specified elsewhere. Pipe material listed therein shall conform to specifications presented in Part 2 of this Section.

PART 3 - EXECUTION

3.01 GENERAL

- A. Care and Handling of Materials. All materials shall be carefully handled in all steps of fabrication, storing, loading, transporting, unloading, storing at the site, and installation, using the means and following the procedures submitted with the approved shop drawings. Pipe slings used during handling, and tie-down straps during transit shall be not less than 4-inch wide flat fiber or plastic straps. During storage and in transit, pipe 8-inches and larger shall be rested on saddles or on another support system approved by the City Engineer, which will insure freedom from damage of the barrel, interior lining, and exterior coating. Not less than 3 saddles or other longitudinal pipe supports shall be used during transit.
- B. Installation
 - 1. The different kinds of piping (buried and exposed) shall be installed in accordance with the drawings and the procedures and methods submitted with the approved shop and erection drawings. Such procedures and methods shall conform to or exceed the minimum requirement of the pipe manufacturer, and shall be as supplemented by the provisions specified herein. The interior of pipe, fittings, and couplings shall be clean and free from contamination when installed and effective means shall be taken to prevent the entrance of foreign matter during progress of the Design-Build Work. The types and sizes of pipes and fittings to be used shall be as specified herein and as shown on the drawings. Where fittings are omitted from the drawings, they shall be the same size as the piping and in all cases shall conform to the plumbing code requirements.
 - 2. All pipes shall be carefully placed and supported at the proper lines and grades and where practicable shall be sloped to permit complete drainage. Piping runs shown on the drawings shall be followed as closely as possible, except for minor adjustments to avoid architectural and structural features. If relocations are required, they shall be approved by the City Engineer prior to the relocation.
- C. Joints. In erecting the pipe, a sufficient number of screw unions, flanged joints, or mechanical couplings shall be used to allow any section or run of pipe to be disconnected without taking down adjacent runs. Screw unions may be employed on pipelines 3-inches in diameter and under. Flanged joints or mechanical couplings shall be employed on pipe 4-inches in diameter or larger unless otherwise shown on the drawings. Dielectric unions must be installed at the junction of dissimilar metals.
- D. Storage and Handling. During storage, handling, and transporting, every precaution shall be taken to prevent damage to pipe. Pipe shall be handled only by means of approved hooks on ends of sections, by means of fabric slings, or other methods approved by the City Engineer for the pipe used. Mortar lined pipe shall be kept sufficiently moist to prevent drying out of the mortar lining prior to installation. Pipe shall be stored in accordance with manufacturer's recommendations.
- E. Verification of Dimensions. All dimensions essential to the correct locations of the pipe, or fit of piping at equipment and valves, or to the proper location and orientation of pipe sleeves and wall castings, or to the avoidance of obstructions or conflict with other improvements, shall be accurately determined by the Company prior to fabrication of the piping involved. All required changes from the nominal locations shown on the drawings shall be made by the Company and shall be included

shall be included as a part of the Design-Build Work hereunder and be approved by the City Engineer.

3.02 BURIED PIPING

- A. Buried Pipe Installation. Buried piping shall be laid to the grades and alignment shown on the drawings, and all trenching, bedding, and backfilling shall conform to the applicable requirements of Division 2; other work shall conform to AWWA Standard C600.

The foregoing requirements shall govern the work, regardless of the type of pipe installed unless a more stringent requirement is specified. When the Design-Build Work is not in progress, open ends of pipe and fittings shall be securely closed. The piping shall be placed when trench and weather conditions are suitable. No pipe shall be placed when trench and weather conditions are unsuitable. No pipe shall be laid in water, and responsibility for the diversion of drainage and dewatering of trenches during construction, including meeting all safety requirements, shall be borne by the Company. All pipe in place shall be approved as to line, grade, bedding, and proper joint construction before backfilling. Pipe shall not deviate from the horizontal and vertical alignment by more than 0.15 feet without prior City Engineer approval. Variance from established line and grade for gravity pipelines, at any point along the length of the pipe, shall not be greater than one thirty-second ($1/32$) of an inch per inch of pipe diameter not to exceed one-half ($1/2$) inch, provided that any such variation does not result in a level or reverse slope. In all backfilling operations, the Company shall be responsible for preventing damage to or misalignment of the pipe.

Pipeline connections to manholes shall be performed with Kor-N-Seal type connectors as shown on the drawings. Pipe ends shall protrude a minimum of 2" and a maximum of 4" beyond the inside wall of the manhole.

- B. Joint Installation. Installation of joints and couplings for buried piping shall conform to the following requirements:
1. Joints for pipe 4-inch diameter and over, shall comply with the supplementary requirements specified herein, and joints of all sizes shall conform to the applicable requirements specified hereinafter for aboveground piping. Care shall be taken to keep pipe in correct alignment when making joints. Friction or lever pullers or other approved means of insuring straight pulling shall be used on pipe larger than 8 inches and also on smaller sizes where damage to the end might occur. The "popping-on" of joints will not be permitted. The fitting of piping to valves, hydrants, and wall castings shall be worked out in advance of installation to ensure correct orientation of the mating ends and bedding of approach piping.
 2. The interior mortar lining of pipe at joints shall be smoothly continuous and of full thickness. Bolts, and other exterior surfaces of buried joints, rods, and couplings shall be given two coats of a 20 mil bituminous coating suitable for the purpose.
 3. Carbon steel piping and appurtenances installed underground or in submerged applications shall be coated in accordance with Section 09905, unless specified otherwise in this Section.
- C. Thrust Blocks. Concrete thrust blocks shall be installed at interconnection points to existing piping. The concrete shall conform to the requirements for 3,000-psi concrete as specified in Section 03301, "Concrete and Reinforcing", and shall be placed against properly dampened, undisturbed soil, centered on the thrust resultant line.

- D. Coverage. Unless otherwise shown on the drawings, all buried piping shall have a coverage of at least 24 inches between the top of the pipe and the finished surface. Variations from the pipeline grade and alignment may be allowed to accommodate fabrication with the approval of the City Engineer. All changes of grade shall require the approval of the City Engineer on the installation drawings.
- E. Installation of Polyethylene Tube Encasement.
1. Installation of polyethylene tube encasement for pipe and fittings shall be in accordance with Method A of ANSI Standard A21.5 and as specified herein. Locations for tube encasement shall be as indicated on the drawings.
 2. Raise a length of pipe at the side of the trench to a height of about 3-feet aboveground level by means of hoisting equipment and a pipe sling or tongs. Using a precut length of polyethylene tubing, 2 feet longer than length of pipe to be covered, slide plastic tubing over spigot end of the pipe up to the pipe sling or tongs. Bunch excess of the plastic tubing near sling or tongs.
 3. Lower the pipe into the trench, joining the lowered length of pipe with that already in place. Shallow bell holes at the pipe joints must be made to facilitate overlapping of the polyethylene at the pipe joints.
 4. Raise bell end of the pipe mechanically or by hand, clear of trench bottom. Slide plastic tube along balance of pipe length to the pipe bell. Leave surplus bunched at the bell for subsequent covering of the joint. Approximately 1-foot of surplus should be provided at each end of pipe.
 5. To cover the joined pipe joint pull the plastic tubing from the preceding length of pipe over the bell end of the pipe, fold around the spigot end of new pipe section and wrap with three circumferential turns of 1-1/2 inch wide polyethylene tape to seal and hold the film in place.
 6. Pull the bunched polyethylene tubing on the new pipe barrel near spigot end over the first polyethylene wrap until it covers the joint, neatly folded behind the bell, seal and hold in place by three circumferential turns of 1 1/2-inch wide polyethylene adhesive tape.
 7. The polyethylene film covering the pipe will be loose. Excess material should be neatly drawn up around the pipe barrel, folded into any overlap on top of the pipe and held in place by means of pieces of the plastic tape at approximately 3 to 5 foot intervals.
 8. Repair any rips, punctures or other damage to the polyethylene with tape or by cutting open a short length of tube, wrapping it around the pipe and securing with tape.
 9. Fittings such as pipe bends shall also be covered by use of the plastic tubing and plastic adhesive tape in much the same manner as the pipe.
 10. Irregular-shaped appurtenances shall be covered by splitting a suitable length of the polyethylene tubing and using the resulting flat sheet with plastic tape to effect the covering of such items.

3.03 ABOVE GROUND PIPING

- A. Pipe Installation. All piping shall be installed in accordance with the erection drawings and the erection procedure submitted with the approved shop or erection drawings. The horizontal piping shall be run parallel to the building walls and shall be level except where otherwise shown or specified; parallel lines shall be grouped on the same horizontal or vertical plane wherever possible. Vertical piping shall be plumb, and the entire piping configuration shall allow adequate clearances for convenient access for painting and preventive maintenance of valves. Piping shall clear obstructions, preserve headroom, and keep openings and passageways clear. If structural difficulties

difficulties or other work prevent the running of pipes or the setting of equipment at the point indicated on the drawings, the necessary minor deviations therefrom, as determined by the Company and approved by the City Engineer, will be allowed, and shall be shown on the erection drawings to be furnished. Except as otherwise shown or specified, piping installation Design-Build Work shall conform to the requirements of the printed or written recommendations of the manufacturer of the product involved for the given conditions, as approved.

B. Joint Installation. Installation of joints and couplings shall conform to the following requirements:

1. Joints and Couplings. Joints and couplings shall be made in accordance with the specified requirements made part of the erection procedure submitted by the Company.
2. Pipe Threads. Pipe threads shall be in accordance with the requirements of ANSI B2.1, and shall be cut full and free from torn or ragged surfaces. No more than three threads on the pipe at any joint shall remain exposed after installation. Threaded joints shall be established with Teflon tape or joint compound or joint compound applied to the male ends only. The use of thread cement or caulking of threaded joints to stop or prevent leakage will not be permitted.
3. Flanged Joints. Flanged joints shall be made with gaskets centered in the joint. Bolts, studs, and nuts shall be lubricated with graphite and oil so that the nuts can be turned by hand. Care shall be taken to prevent excessive initial tension to the bolt and studs so that the tension applied is as nearly uniform as possible. The rust preventive compound applied to the faces of flanges before shipment shall be removed before installation.
4. Tubing. Tubing which is to be soldered shall be cut square, and all burrs shall be removed. Both the inside of the fitting and the outside of the tubing shall be well cleaned with steel wool before sweating. Care shall be taken to prevent annealing of fittings or hard-drawn tubing when making connections. Joints for soldered fittings shall be made with a non-corrosive, paste flux and solid string or wire solder. Soft solder or cored solder will not be permitted. Tubing to be coupled with flared compression type fittings shall conform to the applicable provisions of the Joint Industry Conference (JIC) Standards and the recommendations of the manufacturer.
5. Mechanical Coupling Type Joints of the sleeve, split sleeve, and flanged coupling adapter types shall be made in accordance with the printed instructions of the manufacturer. The pipe ends to receive the couplings shall be finished to the outside diameter and surface finish required by the coupling manufacturer. Prior to assembly, all surfaces which will be inaccessible after installation shall be given protective coating.
6. Joint Harnesses shall be provided at sleeve type coupling joints on pressure pipelines and at all pump discharge piping when shown on the drawings. The harnesses shall be tightened just sufficiently to preclude displacement of the downstream piping under hydraulic thrust.
7. Electrical Insulation Joints shall be provided at all connections between dissimilar metal and ferrous and non-ferrous pipe except where the nonferrous pipe is an electrical non-conductor.
8. PVC Pipe Joints at fittings and couplings to valves and equipment shall be made in accordance with the manufacturer's printed instructions.

C. Pipe Sleeves. All piping which will pass through walls, slabs, footings, or beams shall be provided with specified pipe sleeves with annular space sealed or with wall castings. The Company shall provide the wall sleeves and castings for insertion in the concrete work covered in Section 03301, "Concrete and Reinforcing", and shall verify their correct setting prior to concrete placement. No pipe joint will be allowed to occur in the sleeve. The seal on both ends of the sleeve shall be flush with the concrete surfaces on completion of Design-Build Work and drying of sealant. Caulking

of sealant. Caulking and sealing of wall sleeves shall conform to Section 07900.

3.04 INSTALLATION OF DUCTILE IRON PIPE

A. Pipe Laying

1. Inspection. All pipe shall be carefully inspected by the City Engineer for defects before installation. Such inspection shall include light tapping with a hammer while the pipe is suspended in the air. No pipe or fittings which are cracked or which show defects excluded by the specifications for such pipe or fittings shall be used. All injuries to the protective coating of the pipe or fittings shall be carefully repaired by the Company.
2. Cleanliness of Material. All pipes, valves, fittings shall be carefully cleaned before installation. Every open end of a pipe shall be carefully cleaned before installation. Every open end of a pipe shall be carefully securely plugged or capped before leaving the Design-Build Work.
3. Positioning. For bell and spigot pipe, the position or direction of bells, which shall normally face upstream of the flow, may be altered from the positions shown on the drawings with the permission of the City Engineer. Bells and spigots must be thoroughly cleaned and free from oil, grease, blisters, and excess coating before spigots are inserted into bells. The spigot end of the pipe shall be brought to true line and grade and be inserted to the full depth of the socket before the joints are made. The inner surface of the pipe shall be of uniform width and depth. If any pipe does not allow sufficient space for jointing material, it shall be replaced by one of proper dimensions.
4. Deflection. The maximum deflection in bell and spigot ductile iron pipe joints shall not exceed 75% of the manufacturer's recommendations.
5. Piping Through the Walls. Where pipes pass through walls, care shall be exercised to insure joints being watertight. The pipe shall be free of all dirt and grease to secure a tight bond with the concrete.

3.05 NOT USED

3.06 WELDING

- A. The Subcontractor shall be responsible for the quality of Design-Build Work performed by his welding organization. All welding operators shall be qualified under the Standard Qualification procedure of the American Welding Society. All welds shall be made by an electric shielded arc method of welding. Field welding of all joints shall be in conformance with ASME Boiler Code, Section IX.
- B. The Company shall have the right at any time to call for and witness the making of test specimens by any welder in accordance with these specifications, and the expense of such tests shall be borne by the Subcontractor.
- C. Welds considered by the Company to be deficient in quality, or made contrary to any mandatory provisions of these specifications, shall be removed throughout its depth to expose clean base metal, but in case of a strictly local deficiency, the weld need not be removed throughout its entire length, provided that sufficient amount shall be removed to ensure that sound weld metal, only, remains. A cracked weld shall be removed throughout its length.

3.07 INSTALLATION OF POLYVINYL CHLORIDE SCHEDULE PIPE

- A. Laying. Plastic pipe shall be installed where shown on the drawings. The trench for buried plastic piping shall be excavated to 4 inches below the bottom of the pipe and filled to the proper grade with sand thoroughly tamped, as specified in Section 02200. After the pipe is laid the trench shall be backfilled with sand to 6 inches above the top of the pipe. The remainder of the trench shall then be backfilled in accordance with Section 02221.
- B. Fittings. Fittings for plastic pipe shall be flanged or of the socket type using the solvent weld process. Transition from plastic to steel pipe shall be by flanges or by threaded slip joint plastic adapter or fitting. No plastic pipe shall be threaded. No solvent shall be used on threaded end of plastic adapters or fittings.
- C. Anchorage. All line valves and fittings at downpipes shall be anchored to the wall in a manner to prevent stress and rotation of the pipe.
- D. Joints. Joint material for plastic pipe shall conform strictly to the printed recommendations of the pipe manufacturer. Solvent weld connections shall be made as follows:
 - 1. Joints shall be wiped clean and a solvent supplied by the manufacturer applied to both male and female connections.
 - 2. Two applications of the solvent shall be made.
 - 3. The treated surfaces shall be forced together as soon as the pipe material becomes soft or tacky and given 1/4 turn as recommended by the manufacturer.

3.08 INSTALLATION OF THICKWALL POLYVINYL CHLORIDE PRESSURE PIPE

- A. Installation of this pipe shall be in accordance with AWWA C900. The trench for thick wall PVC pipe shall be over excavated to a depth of 4-inches below the bottom of the pipe and filled to the proper grade with sand, thoroughly tamped, as specified in Section 02200. After pipe is laid the trench shall be backfilled with sand to 12-inches above the top of the pipe.

3.09 INSTALLATION OF DOUBLE CONTAINMENT PIPING SYSTEM

- A. Install double-containment piping to comply with manufacturer's recommended procedures.
- B. Installers shall be pre-qualified through sufficient training in butt fusion techniques on PVDF materials, according to ASTM D2657 Section 9.
- C. PVC and CPVC shall be solvent welded in accordance with procedures described in ASME B.31.3, Chapter VII for bonding plastic piping.
- D. Hot gas welding shall not be allowed for wetted components.
- E. Manufacturer/Manufacturer's Representative shall provide on-site training in the assembly, installation, and operation of the double-containment systems.
- F. Install continuous running pull rope for installation of leak detection cable if required. Manufacturer shall supply pipe spools with pull rope in place.
- G. Primary pipe shall be tested hydrostatically to 150% of operating pressure per ASME B31.3 part 345 or per local code, for a period of one hour. Use Soap coating to see visual leaks.
- H. Secondary piping shall be tested to 150% of operating pressure per ASME B31.3 or per local codes

codes for a period of 2 1/2 hours. Use soap coatings to see visual leaks. The primary pipe must be pressurized to the same pressure as the test to prevent collapsing of primary pipe.

- I. Install leak detection in accordance with manufacturer's procedures. Stations shall be maximum 100 feet center to center.
- J. Following installation of the systems, the primary piping system shall be flushed clean. The Company shall check the operation of all valves, leak detection devices, and appurtenances.

3.10 INSTALLATION OF REINFORCED CONCRETE PIPE

- A. Pipe Bedding. Reinforced concrete pipe 36-inch in diameter and less, shall have a minimum of four inches of bedding under the pipe. For pipes larger than 36-inches in diameter, minimum bedding thickness shall be 1/12 of the outside diameter of the pipe.
- B. Laying Reinforced Concrete Pipe. Reinforced concrete pipe with elliptical cage reinforcement shall be laid with the minor axis of the reinforcement cage in a vertical position.
- C. Pipe Junctions. Pipes of different sizes, if not at a structure, shall be jointed by butt joints unless a transition structure is shown on the drawings. The opening between pipes at the butt joint shall be closed with a concrete collar 4-inch wide surrounding the smaller pipe above subgrade. The outside surface of the collar shall conform to the outside surface of the larger pipe. The inside offset in the invert or crown and around the perimeter shall be eased off by forming a concrete mortar fillet extending from the joint into the larger pipe a distance equal to twice the offset at its maximum and tapering to a point where the pipe surfaces coincide.
- D. Jointing of Reinforced Concrete Pipe. All joints shall be made with neoprene rubber gaskets installed in full accordance with the manufacturer's recommendations.

3.11 INSTALLATION OF EXPANSION JOINTS

- A. Elastomeric expansion joints shall be installed as shown, in strict accordance with the manufacturer's instructions.

3.12 CHANGES IN LINE AND GRADE

- A. In the event that obstructions not shown on the drawings are encountered during the progress of the Design-Build Work which will require alterations to the drawings, the City Engineer shall have the authority to change the drawings and order the necessary deviation from the line or grade. The Company shall not make any deviation from the specified line or grade in excess of 0.15 feet without approval by the City Engineer.

3.13 PROTECTIVE COATINGS

- A. Painting and coatings shall conform to the applicable requirements of Section 09905, "Painting and Protective Coatings".

3.14 IDENTIFICATION OF PIPING

- A. Label all exposed piping after painting using outdoor grade pressure sensitive adhesive-backed vinyl pipe markers conforming to ANSI A13.1. Markers for 2-inch pipe and smaller shall fully encircle the pipe and be Seton Style BB or approved equal. Markers for pipe larger than 2-inches shall be Seton Style AA or approved equal. All markers shall have adhesive-backed flow arrows of the same color secured at each end and fully encircling the pipe. Flow arrows shall be Seton Style AR or approved equal.
 - 1. Pipe markers shall be located at minimum 15-foot intervals and at all changes in direction unless otherwise approved by the City Engineer. All markers shall be clearly visible. Piping capable of being viewed from two sides such as, but not limited to, vertical risers, and hanging horizontal drain lines, shall have markers secured on each side.
- B. All buried piping, 1-inch diameter and larger shall be color coded by means of a securely attached tape spirally wound continuously around the pipe so that the tape is visible on the crown of the pipe every two feet. The tape shall be secured to the pipeline at minimum 10-foot intervals with cloth industrial duct tape. The tape shall be a minimum 3-inches wide, 4-mil thick, with the words, "CAUTION ***** LINE" permanently imprinted on the visible side. ***** shall be the label wording identifier as shown on the following schedule. The continuous warning message shall be repeated every 16 to 36 inches. The minimum tensile strength of the tape shall be 40 pounds per 3-inch width strip. Tape shall be as manufactured by Linetec, Inc., St. Schaumburg, IL or approved equal. Tape shall be secured over polyethylene tubing on ductile iron pipe.
- C. In addition to the above requirements, all PVC-3 piping shall be installed with a detectable tape placed directly over the pipeline 12"-18" below grade. Tape shall be as specified above but will incorporate the addition of a metal ribbon to facilitate at-grade sensing with a standard metal detector.

3.15 TESTING

- A. The Company shall perform hydrostatic, leakage, and operational tests as specified herein. All equipment, including, but not limited to, pumps, gauges, and special fittings required to perform the testing shall be provided by the Company. The Company shall perform all excavation and other work required to locate and repair leaks and correct other defects which may be disclosed or develop under tests. The Company shall replace all coating, painting, backfill, or other permanent work removed in locating or repairing leaks and correcting defective piping. All gauges and control devices connected to lines being tested must be disconnected for the duration of the test. Water shall not be used in testing air lines, chlorine gas lines, or other gas carrying pipes. High pressure air testing of PVC or FRP pipe in exposed or above ground installations is not permitted. All tests shall be witnessed by the City Engineer or his representative. The Company shall notify the City Engineer's representative a minimum of 24 hours prior to requesting inspection of tests.
- B. Testing Requirements
 - 1. Gravity Sewer Pipes or Other Pipelines Having Free Surface Flow Except Storm Drainage Pipelines. PVC gravity sewer pipe or other pipe having free surface flow shall be given a water exfiltration test as specified herein. The Company has the option of using a low pressure air test in lieu of the water exfiltration test. If excessive groundwater is present which precludes use of the exfiltration test, the Company shall use either the low pressure air test or infiltration test.

2. Water Lines, Sewage Force Mains, Sludge Lines and Other Pressure Piping Carrying Liquids. Water lines, sewage force mains and other pressure piping carrying liquids having bell and spigot gasketed joints shall be given a pressure and leakage test in accordance with AWWA C-600 unless specifically modified herein.
3. Pressure Pipe, Flanged or Welded Joints. PVC, steel, ductile iron or other pipe material, with solvent welded, welded, threaded, flanged, grooved end or flexible couplings and joints shall be pressure tested as specified above. No leakage shall be permitted.
4. Gravity Storm Drainage and Foul Air Pipe. No special pressure or leakage testing is required. Leakage shall be minimized by installation in a workmanlike manner with no visible sources of leakage in accordance with the manufacturer's recommendations.
5. Pressure Air and Gas Piping. All piping carrying air or other gasses under pressure shall be given a pressure test as specified herein. No leakage is permitted. Low pressure air piping shall be tested pneumatically. Air pressure of 20 pounds per square inch shall be applied to piping and fittings. High pressure air piping shall be tested to 200 psi unless otherwise specified in the schedule. There shall be no drop in pressure in a 24-hour period. Leaks shall be located and repaired to the satisfaction of the City Engineer. Pressure drops due to thermal contraction are acceptable if the pressure returns to the original test pressure after 24 hours.
6. Vent Piping. Vent piping shall be filled with water to the top of the system for a period of 24 hours with no measurable leakage.

C. Pressure Tests.

1. General. All piping, including valves, shall be field-tested at a hydrostatic pressure equal to the pipe pressure class (unless specified otherwise in the Testing Schedule), corrected to the elevations of the test gauge, with duration of two hours minimum, for each pressure test, unless code requirements dictate a longer duration. Air piping shall be tested using air or nitrogen. Pressure tests shall be recorded by the Company. Copies of all test report forms shall be forwarded to the City Engineer.
2. Thrust Blocks. Temporary or permanent thrust blocks or bulkheads or restrained joints shall be placed as required prior to tests, and the Company shall provide all necessary braces, plugs, thrust blocks, caps, flanges, and other materials to permit proper performance of the pressure testing; tests shall not be conducted until the concrete thrust blocks are capable of withstanding the loads produced.

D. Leakage Tests.

1. General. Leakage tests shall be conducted concurrently with the pressure test. The lowest pressure during the leakage test shall be no less than 5 psi below the pressure used in the pressure test. The allowable leakage shall be determined in accordance with AWWA C-600. The duration of the test shall be not less than two hours. Measurement shall be made by means of a calibrated suction tank showing the amount of water required by the test pump to accurately maintain the specified test pressure. Tests shall be performed only in the presence of the City Engineer, or, if scheduling of tests is such that the City Engineer cannot attend due to conflicting commitment, tests may be performed without the City Engineer's presence if the Company obtains written permission to do so from the City Engineer prior to initiation of testing. No test report will be accepted unless proof of compliance with the foregoing requirement accompanies the test report.

E. Low Pressure Air Test. Conduct in conformance with ASTM C-828.

- F. Exfiltration Test of Sewers. Exfiltration tests shall be performed by bulkheading the section of sewer under test at the manhole, at the lower end, and filling the sewer with reclaimed water until the water level reaches elevation 10.5. Leakage will be the measured amount of water added to maintain the level in the higher end manhole. The duration of the test shall be a minimum of four (4) hours with readings at 30 minute intervals. The quantity of leakage for any section of the sewer shall not exceed 250 gallons per inch of internal diameter of pipe, per mile of sewer per day.
- G. Sewer Manhole Risers. All sanitary sewer manhole risers including the lift station wet well, if not tested in conjunction with the exfiltration test of sewers shall be tested for leakage by plugging sewers and filling manhole with water to the top of the manhole. The water shall stand for a 4 hour period and during that time the water level shall not drop.

PIPE TESTING SCHEDULE

Process Pipe (PSI) **	Pipe Designation	Operating Condition	Test Fluid	Test Pressure (PSI)
Aqua Ammonia	AA	Pressure	Water	50
Compressed Air	CA	Pressure	Air	20
Drain, Gravity Drain	D	Gravity	Water/Air*	Exfiltration/10
Filtered Water	FDW	Low Pressure	Water	100
Finished Water	FW	High Pressure	Water	238
Potable Water	POT	High Pressure	Water	200
Permeate	PERM	Low Pressure	Water	100
Concentrate	CONC	Low Pressure	Water	120
Raw Sewage, Force Main	RS, FM	Raw Sewage	Water	50
Raw Water, Raw Groundwater	RW, RGW	High Pressure	Water	150
Recirculation	RECIRC	Low Pressure	Water	50
Sanitary Sewer	SS	Gravity	Water/Air*	Exfiltration/3.5
Sodium Hypochlorite, except final trim	NaOCl	Low Pressure	Water	50
Sodium Hydroxide	NaOH	Low Pressure	Water	50
Sodium Hypochlorite, final trim	NaOCl	High Pressure	Water	200
Sulfuric Acid	SA	Low Pressure	Water	50
Lime system Feed	LF	Low Pressure	Water	100
Hydrofluorosilicic Acid	HF	Low Pressure	Water	100
Polyphosphates	P	Low Pressure	Water	100
Carbonic Acid	CO2	Low Pressure	Water	100
Antiscalant	AS	Low Pressure	Water	100

* Company's Option

** With the exception that pipelines not subject to pumping (i.e., tank interconnecting pipelines) shall be subject to a test pressure equal to 1.5 times the maximum static head expected.

Off spec water (OSW) piping shall be tested similar to that of filtered water (FDW), at 100 psi.

3.16 FLUSHING

- A. General. All piping shall be flushed clean of all dirt and foreign material following completion of the hydrostatic and leakage test. Air and gas piping shall be purged with air or nitrogen gas as directed by the City Engineer.
- B. Equipment and Supplies. The Company shall provide all equipment, and supplies for performing the Design-Build Work, and shall waste the water at locations or by procedures approved by the City Engineer.

3.17 DISINFECTION

- A. Disinfect the following pipelines in accordance with AWWA Standard C651.
 - 1. Filtered Water – FDW
 - 2. Finished Water – FW
 - 3. Potable Water – POT
 - 4. Raw Water – RW
- B. The Company shall be responsible for furnishing fittings and all special pipe taps required for injecting any required sterilization solution.

Table 1 - Pipe Material Schedule

Service	Line	Application	Sizes	Pipe Material	Joints
Aqua Ammonia	AA	Exposed	All	Black Steel	Threaded/Flanged
		Buried	All	PVC Schedule 80 Double Walled	Welded or threaded, Double Walled
Compressed Air	CA	All	All	Stainless Steel	Welded/Flanged
Drains	D	Exposed	≥4"	Ductile Iron	Flanged
			<4"	Sch 80 PVC (PVC-1)	Solvent Welded
		Buried	All	Cast Iron, Sch 80 PVC (PVC-1), or SDR-35 PVC (PVC-2)	Push-On/Solvent Welded
Lime System Feed, Filtered Water, Finished Water	LF, FDW, FW	Exposed	All	DI, Steel	Flanged
		Buried	All	Super Duplex 20	Welded / Flanged
Potable Water	POT	Exposed	<4"	CPVC Schedule 80	Solvent Welded
			≥4"	Ductile Iron	Flanged
		Buried	<4"	PVC Schedule 80 (PVC-1)	Solvent Welded
			≥4"	Ductile Iron	Rest. Push-On/Mechanical

Table 1 - Pipe Material Schedule (Continued)

Service	Line	Application	Sizes	Pipe Material	Joints
---------	------	-------------	-------	---------------	--------

Service	Line	Application	Sizes	Pipe Material	Joints
Raw Sewage, Force Main	RS, FM	Exposed	3" and below	316LSS	Flanged/Welded
		Exposed	4" and above	Ductile Iron	Flanged
		Buried	3" and below	PVC Schedule 80 (PVC-1) PVC C900	Solvent Welded
		Buried	4" and above		Rest. Push-On/Mechanical
Raw Water	RW	Exposed	All	DI or Steel	Flanged
		Buried	≥ 12"	DI, Steel, PVC C900	Push On, Restrained Jt./Welded
			≤ 10"		Restrained Push on Mechanical Joints
Raw Water	RW	Exposed	All	DI or Steel, Super Duplex 20 (after acid addition)	Flanged
		Buried	All	DI, Welded Steel, Super Duplex 20 (after acid addition)	Welded, or Restrained Jt.
Recirculation for Aerator Cleaning	RECIRC	Exposed	All	(PVC-1)	Flanged
		Buried	4" and above	PVC C900 (PVC-3)	Restrained Push-On/Mech.
Sample	S	All	All	Sch 80 PVC (PVC-1)	Solvent Welded
Sanitary Sewer	SS	All	All	PVC, SDR-35 (PVC-2)	Push-On
Sodium Hypochlorite Solution	NaOCL	Exposed	All	PVC Sch 80 (PVC-1)	Threaded/Flanged
		Buried	All	PVC Sch 80, Double Walled	Threaded/Flanged, Double Walled
Sodium Hydroxide Solution	NaOH	Exposed	All	Sch 80 Black Steel or CPVC Sch 80	Solvent Welded
		Buried	All	CPVC Sch 80, Double Walled	Solvent Welded, Double Walled
Stormwater	ST	All	All	Corrugated Metal or Reinforced Concrete	Banded or Push-On
Sulfuric Acid	SA	Exposed	All	Halar Double Walled	Fusion Welded
		Buried	All		Welded, Double Walled
Vent	V	Exposed	All	Sch 80 PVC (PVC-1)	Solvent Welded
Hydrofluorosilicic Acid	HF	Exposed	All	PVDF	Socket or Butt Fusion
		Buried	All	PVDF Double Walled	Socket or Butt Fusion
Polyphosphates	P	Exposed	All	Sch 80 CPVC	Solvent Welded
		Buried	All	Sch 80 CPVC Double Walled	Solvent Welded
Carbonic Acid	CO2	All	All	Sch 80 PVC Double Walled	Solvent Welded

Service	Line	Application	Sizes	Pipe Material	Joints
Antiscalant	AS	Exposed	All	Polypropylene	Socket or Butt Fusion
		Buried	All	HDPE Double Walled	Socket or Butt Fusion
Permeate	PERM	Exposed	All	316L SS	Welded or Flanged
		Buried	All	HDPE	Socket or Butt Fusion
Concentrate	CONC	Exposed	All	Super Duplex 20	Welded or Flanged
		Buried	All	HDPE	Socket or Butt Fusion

Off spec water (OSW) shall have the same pipe material requirements as potable water (POT).

END OF SECTION

SECTION 15100
VALVES AND ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Company shall furnish all tools, equipment, materials, and supplies and shall perform all labor required to furnish and install all valves and appurtenances as indicated on the drawings, and specified herein.

1.02 SCOPE OF WORK

- A. Design-Build Work Included in This Section. The Design-Build Work of this Section shall include the furnishing, installation, and testing of all valves and required appurtenances as specified herein, shown on the drawings and as required to make the entire facility operable except for those valves and appurtenances required to be provided in other sections of these specifications. Items to be provided include but shall not be limited to the following:
 - 1. Valves
 - 2. Operators and valve boxes
 - 3. Motor Operators
 - 4. Pipe Supports
 - 5. Hydraulic Operators and Hydropneumatic System
- B. Related Design-Build Work Specified Elsewhere:
 - 1. Piping and Appurtenances, Section 15060
 - 2. Excavation, Backfill, and Compaction, Section 02221
 - 3. Painting and Protective Coatings, Section 09905
 - 4. Electrical and Instrumentation, all applicable sections

1.03 SUBMITTALS

- A. The Company shall provide the following in conformance with applicable requirements contained in Appendix 5 of the Service Contract and Section 11001.
 - 1. Shop Drawings. Submit shop drawings for process valves, regulators and miscellaneous components. Shop drawings shall be complete with bill-of-materials showing kind and class of materials, and catalog and engineering data showing compliance with the specified requirements.
 - 2. For each type and model of valve provide:
 - a. Assembly instructions and spare parts list
 - b. Preventative/corrective maintenance instructions
 - c. O&M Manuals per Appendix 11 of the Service Contract.
 - 3. For each motor driven actuator provide motor currents at the specified voltage for each actuator, corresponding to locked rotor, maximum seating torque, average running load and speed. Supplier shall give full information concerning actuator dimensions and weights.

4. Erection Drawings. Erection drawings shall include the procedures to be used in setting, supporting, and/or anchoring the valves, the fitting of line pipe to the valves for proper coupling, and for adjusting and testing all valve assemblies.

1.04 QUALITY ASSURANCE

- A. All process valves, regulators and miscellaneous components shall be new, free from defects or contamination, and wherever possible shall be the standard product of the manufacturer.

1.05 EQUIPMENT STORAGE AND HANDLING

- A. Process valves, regulators and miscellaneous components shall at all times be handled with equipment designed to prevent damage to the components.

PART 2 - PRODUCTS

2.01 GENERAL

- A. All valves shall be provided as shown on the drawings, schedules, and as specified herein. All valves shall be designed for drip-tight shutoff. Unless otherwise shown or specified, aboveground valves shall be flanged or screwed, non-rising stem, handwheel or lever operated, and buried valves shall be non-rising stem, wrench operated restrained, mechanical or push-on joint, or flanged. Where not otherwise designated, all valves over 4-inch size shall be provided with valve supports of design shown or approved. All bronze parts of valves shall be constructed of high-strength material containing not more than seven percent zinc and not more than two percent aluminum. The valve assemblies shall be furnished complete and adequate for the specified or shown purpose, and shall include all essential components of equipment, together with all mountings and other appurtenances normal and necessary for proper installation, whether shown or not.

2.02 PRESSURE RATING

- A. All process valves shall be rated for a working pressure equal to or more than the pressure rating of the connecting piping unless specifically shown otherwise on the drawings or specified in other sections of these specifications.

2.03 OPERATORS

- A. General. The operators shall be sized based on the maximum expected torque as per valve manufacturer's recommendations and in no case shall rim pull exceed 40 pounds. The responsibility for proper operation shall reside with the valve supplier and Company.
- B. Manual Operators. Manual operators, except where otherwise shown or specified, shall be worm-gear type, Limitorque HBC, E-I-M Type MG, Dezurik, or approved equal and shall include AWWA input limit stops. The axis of the worm shaft shall remain fixed during operation. A handwheel shall be provided except where an extension stem or valve box, tee wrench and street box are required. Extension stems and accessories shall be sized for valve manufacturer's recommendations. Stop limiting devices shall be provided to limit travel. All submerged operators shall be completely watertight and shall be capable of withstanding a minimum of 30 feet of water submergence, with the gearing totally enclosed and permanently grease packed.

1. Gate and Globe Valves. All gate, globe and angle valves shall be fitted with handwheels of suitable size or gear operators in accordance with the manufacturer's recommendation.
 2. Ball Valves. All ball valves 3-inch and smaller in size shall be lever operated. See 2.07D regarding the 24-inch AWWA metal seated ball valve.
 3. Butterfly Valves. All butterfly valves 4-inch and smaller in size shall be lever operated and valves six-inch and larger in size shall be equipped with handwheel actuators per AWWA C504 and C540. The operators shall be furnished by the manufacturer of the valve, who shall be responsible for the compatibility and adequacy of both the valve and operator. Valve operators shall be sized for the maximum torque developed by the maximum pressure in the pipeline in which the valve is to be in service and all exposed nuts, bolts, springs, washers, shall be stainless steel.
 4. Chainwheel Operator. All valves and dampers six feet or more above the floor level shall be provided with chainwheel operators in lieu of the handwheel or lever operator and shall be the valve manufacturer's standard, with galvanized chain to be furnished in the length required for operation.
 5. Wrench Nut Operation. Unless otherwise shown, an AWWA nut or shaft key, as applicable, shall be provided in lieu of handwheel where required for connection to extension stem or as indicated on the drawings. Nut shall be constructed of cast iron. No submerged or buried operator shall require maintenance following installation. Suitable gaskets, O-rings, and other features shall ensure permanent watertightness.
- C. Electric Operators. Electric type operators shall include the motor, operator unit gearing, limit switches, torque switches, declutch lever, auxiliary handwheel, reversing starter, switches, mechanical position indicator, and accessories as indicated herein. The valve actuator motor and all electrical enclosures shall be weatherproof, NEMA 4X, as a minimum unless explosion-proof is indicated. The power gearing shall consist of helical gears of heat-treated steel, and worm gearing of hardened alloy steel. All power gearing shall be grease lubricated with high speed parts on antifriction bearings. It shall be possible to remove the motor operator from the valves without taking the valve out of service. Actuating speed shall be as specified. At least two spare switches shall be provided for each size and type of switch furnished. The responsibility for proper operation shall reside with the valve supplier. Valve manufacturer or representative shall provide a minimum of one day of on-site start up and maintenance instruction for the electric operated valves.
1. Motors shall be TENV squirrel cage induction motors meeting the requirements for electric motors as specified in Section 16150. Available operating torque shall be at least two times the maximum torque requirements as stated by the valve manufacturer. The motor shall be sized to open or close its associated valve when the supply voltage is 90 percent of rated voltage. The motor shall have prelubricated antifriction type bearings. Electrical power supply shall be as indicated on the schedule or shown on the drawings.
 2. Controls. Each actuator shall be equipped with a reversing starter (Electro-Mechanical or Solid State as required), control relays, control transformer (if required), 2-position limit switches and 2-torque limiting switches. Additional items including extra limit switches, H-O-A switches, open-auto-close switch, open/close indicating lights, position controller (with braking) for 4-20 mAdc input (where required), shall be supplied as indicated on the drawings.
 3. Position Limit Switches shall be DPDT (with electrically isolated contacts) and provide for both open and close positions of travel and shall be connected directly to the valve through continuous gearing, and following its position at all times. Switches shall be rated 10A at 120 VAC. The actuating point shall be adjustable over at least 50 percent of the travel.

4. Torque Limiting Switches shall be provided and be responsive to the mechanical torque developed in seating, backseating, or by obstruction. The torque switch shall operate a calibrated dial integrally mounted and directly related to the torque output of the operator. Torque control accuracy shall be within plus or minus 5 percent. The use of torque wrenches for calibration shall not be required.
5. Pushbutton Control Station. A local control station shall be provided which shall include a local-remote selector switch, open-stop-close pushbutton, and open and closed indicating lights. Control voltage shall be 120 VAC.
6. Position Controller, when specified, shall utilize an independent position feedback potentiometer and shall accept a 4-20 mA_{dc} signal for modulating valve position, unless otherwise specified. Final positioning accuracy shall not be less than 1 percent of position specified by the signal. A damping circuit shall prevent overshoot in excess of 2 percent for a full-scale step input. The controller may be separately housed but must be of the same class as the actuator housing. Power shall be derived from the actuator power supply.
7. Nameplate and Start-up Kit. The actuator nameplate shall be of corrosion-resistant material and shall include serial number, actuator type, voltage, motor-locked rotor, and average load currents at the voltage for which the motor is connected. Each actuator shall be supplied with a start-up kit including wiring diagram and start-up instructions in the terminal housing, together with spare cover O-rings or gaskets and cover screws.
8. Coordination with Instrumentation. It shall be the responsibility of the Company to coordinate the actuator requirements with the instrumentation requirements to ensure compatibility of control interfacing and the operations.
9. Controls for electric operators shall be accessible from, and mounted not lower than three feet or higher than five feet above a walkway or floor.
10. Manufacturer. Electric valve actuators shall be the LY series as manufactured by Limitorque Corporation. All electric valve actuators shall be of the same manufacturer for each type of valve furnished.
 - a. Features: Max full stroke time 5 minutes. Include position controller, position lights, and position transmitter.
11. If the Company supplies other than the named equipment, then the following shall also be supplied:
 - a. One (1) week of on site start-up and debugging time at no additional cost. A factory-trained technician shall be available on site within one (1) week's notice from City;
 - b. For each valve supplied four (4) complete sets of repair/replacement parts required for any "owner maintenance" items described in the standard product operation and maintenance manuals supplied with the equipment;
 - c. In the event that the valve operator has any sealed units (electronics) and has no "owner maintainable parts," then the warranty shall include: parts, labor, and shipping to return the device for repair and be extended to five (5) years;
 - d. Three (3) weeks of training by a factory-trained engineer or technician for three of City's technicians. This training shall include component level troubleshooting and software. This training shall be provided at no additional cost to City.

2.04 VALVE BOXES AND EXTENSION STEMS

- A. General. Unless exposed operators are shown or specified, the Company shall provide cast-iron valve boxes or floor boxes over each direct buried or submerged valve.

- B. Valve Boxes. Valve boxes shall be adjustable to fit the depth of earth cover over the valve and shall be designed so as to prevent the transmission of surface loads directly to the valve or piping. Valve boxes shall have an interior diameter of not less than five inches. Valve boxes shall be installed to reserve a minimum of 50 percent (1/2) of the adjustment for the future extension. Extension sections shall be cast iron only. The valve boxes shall be constructed to prevent tipping or rattling. Boxes shall be a minimum 3/16-inch thick as manufactured by U.S. Foundry or approved equal. All valve boxes and exposed operators shall be installed in a protective concrete collar as shown on the drawings. Valve box covers shall be provided with identifiers cast into the cover as shown on the drawings.
- C. Floor Boxes. Floor boxes shall be used with nut style actuators and shall include cast iron covers. Box depth shall not be less than the thickness of the floor and shall be a minimum of 5 inches in diameter. All boxes shall have an annular ring cast into the box. Floor boxes shall be similar to those manufactured by Dezurik or approved equal.
- D. Valve stem Extensions. Valve stem extensions shall be installed (pinned on)during construction to bring the operating nut to within 6" to 18" of surface grade. Extension stem shall have a 2-inch operating nut.

2.05 FLOAT VALVES

- A. Float valves shall be 150 lb flanged modulating, diaphragm operated globe style valves Model 628-01 as manufactured by Cla-Val, Newport Beach, CA or approved equal.
- B. Valve Materials
 - 1. Body and cover Ductile Iron ASTM A-536
 - 2. Disc Retainer and Diaphragm Washer Cast Iron
 - 3. Trim Bronze ASTM B62
 - 4. Disc Buna N Rubber
 - 5. Diaphragm Nylon Reinforced Buna N Rubber
 - 6. Stem Nut & Spring 304 Stainless Steel
- C. Pilot and Float Materials
 - 1. In contact with water operating fluid, 304 Stainless Steel with Buna N Seals
 - 2. Float Linkage Brass
 - 3. Float Rod PVC
 - 4. Base Plate Enameled Steel
 - 5. Float Polypropylene
 - 6. Stilling Well PVC pipe 8 inches diameter
- D. Operating fluid will be potable water

2.06 GATE VALVES

A. Bronze Valves

1. Valves 3-inch and smaller, unless otherwise specified, shall be 125-pound, non-rising stem, screwed bonnet, solid wedge disc, bronze gate valves. Valves shall be threaded unless otherwise called for on the drawings. Small diameter gate valves shall conform to MSS SP-80 and meet material and design requirements of Federal Specification WW-V-54d Class A Type 1 valves. Valves shall be Crane No. 1701, or approved equal.
2. Gate valves 4-inches through 12 inches in size shall be resilient-seated, non-rising stem type with 2-inch operating nuts for buried service and handwheels for exposed service conforming to AWWA Standard C-509.
 - a. Large diameter gate valves, except as otherwise noted, shall be iron body, bronze trimmed, solid resilient wedge with epoxy coating. Valves shall provide bubble-tight shutoff in either direction with a working pressure of 200 psi. All valves shall open with left hand turn, i.e., counter-clockwise. Stuffing boxes shall be of the "O-Ring" type.
 - b. Face to face dimension for flanged valves shall conform to ANSI B16. Mechanical joints shall conform to ANSI 21.11.
 - c. Exposed valves shall be coated inside with a fusion bonded epoxy 8 mils thick which meets or exceeds AWWA C550. Buried valves shall be coated both inside and outside.
 - d. Stuffing box follower bolts shall be of bronze.
 - e. When full open, each valve shall have a clear waterway equal to the nominal diameter of the pipe. The operating nut or wheel shall have an arrow cast in the metal indicating the direction of opening. Each valve shall have the manufacturer's distinctive marking, pressure rating and year of manufacture cast on the body. Prior to shipment from the factory, each valve shall be tested by applying it to a hydraulic pressure equal to twice the specified working pressure.
 - f. Resilient-seated gate valves shall be American Flow Control Series 500 or approved equal.

B. HI-PVC Valves. All HI-PVC valves shall conform to ASTM D 1784 Cell Classification 12454A. Valves shall be PVC body with FKM or EPDM seals and PP tapered cylindrical plug. Valves shall be flat faced flanged end type conforming to ANSI B16.5 bolt pattern for 150 lb flanges. The valve shall have a non-rising stem, visual position indicator, handwheel for operation, and clean-out plug on bottom of valve body.

C. Polypropylene Valves. Polypropylene Gate Valves shall conform to ASTM D 4101 Cell Classification PP0210B67272. Valves shall be flat faced flanged end type conforming to ANSI B16.5 bolt pattern for 150 lb flanges. The valve shall have a non-rising stem, visual position indicator, handwheel for operation, and clean-out plug on bottom of valve body.

2.07 BALL VALVES

A. General. Ball valves shall be the manufactured product of an experienced manufacturer regularly producing the type of valve for use in similar installations. The valves, as furnished and installed, shall be compatible with the materials and layout provided and shall conform to the drawings unless otherwise approved.

B. PVC Ball Valves. All PVC ball valves shall be of unplasticized, Type 1, Grade 1, PVC conforming

conforming to the requirements of ASTM D-1784, and shall be of the True Union design with a union on each end. All valves shall be rated at 150 psi at 75°F and shall be handle operated unless otherwise specified. Valves shall have Teflon seats and viton O-rings. PVC ball valves shall be Celanese Chemtrol, Prominent or approved equal. Ball valves for use on aqua ammonia and sodium hypochlorite applications shall include a degassing feature to allow accumulated ammonia or hydrogen gas to be released downstream of the valve with the valve shut off.

- C. Bronze Ball Valves. All valves shall have a round port with diameter equal to the nominal size. Valves shall be of the two-piece construction and shall have Teflon seats sealing in either direction. Valves shall have bronze bodies conforming to ASTM B584. Balls on valves < 2" shall be stainless steel and brass for valves > 2". Pressure rating shall be 600 WOG for 1/4"-2" sizes and 400 WOG for 2½"-3" sizes. Metal ball valves shall be Crane No. 9302, 9302-S or approved equal.
- D. Polypropylene Valves. All valves sized ½" – 6" shall be of True-Union design with 2-way blocking capability. PTFE seats shall have elastomeric backing cushions to provide smooth even stem torque and to compensate for wear. Valves shall feature molded ISO mounting top flange for actuation installation and Panel Mount feature on bottom of valve for securing in-line. The handle shall double as the spanner wrench for maintenance and carrier adjustment.
- E. E-CTFE Valves. All valves ½" – 1" shall be molded from Solvay E-CTFE resins, and come with Litharge/fluorine elastomer O-Ring seals suitable for use with high concentration (98%+) Sulfuric Acid Applications.
- F. Metal Seated Ball Valves.
 - 1. Furnish and install metal seated ball valves, trunnion mounted, in complete accordance with AWWA Standard C507, latest edition, with full 100 percent circular port opening. Provide the latest standard product of a manufacturer regularly engaged in the design and manufacture of metal seated ball valves, APCO-Willamette of Schaumburg, IL, or approved equal. Provide valve actuators in accordance with AWWA C540, latest edition.
 - 2. The ball valve manufacturer shall provide a complete package, including the valves, hydraulic operators, unit control panel, and hydro-pneumatic system to assure proper operation of the entire system.
 - 3. Provide Class 300 ball valves consisting of valve body and fixed body seat, rotating ball with integrally mounted ball seat, operating mechanism integrally mounted to valve body, and valve actuator integrally mounted to operating mechanism. Provide flat face flanged ends per ANSI B16.1 Standards with Class 250 flanges.
 - 4. Provide a four-piece valve body with two end pieces and a two-piece center section. Provide a corrosion resistant fixed metal body seat for drop tight sealing in the opposite direction of the pump discharge, through-bolted together and sealed with O-rings against the two piece center section, also through-bolted, containing the ball, and sealed with O-rings. Provide the center section with integrally cast bronze bushed trunnions, rigid mounting for the operating mechanism, and integrally cast support pad.
 - 5. The ball shall be of one-piece construction with corrosion resistant "flexible" metal seat and integrally cast bronze or stainless steel bushed trunnions.
 - 6. Provide one set of valve seats of corrosion resistant Monel (Alloy 400) fixed body seat, and rotating Type 304 stainless steel seat, spherically generated on an eccentric seating axis to provide long life with virtually no contact except during initial unseating. Retain the seats by

- purely mechanical means with a bearing pressure not exceeding 1000 psi at the design differential pressure of 75 psig.
7. Provide sleeve type bearings on the ball and body trunnions, constructed of long life bronze of low zinc content or corrosion resistant stainless steel, with bearing pressures not exceeding 2000 psi at design differential pressure. Provide mating bearing surfaces with a hardness difference of at least 50 points Brinell.
 8. Provide operating shaft of high alloy high strength stainless steel ASTM A564-17-4 Double Aged H1150, ground and polished. Provide the shaft as an extension of one of the ball trunnions machined for a firm press fit and attached with a high alloy high strength steel pin. Pass the shaft through the center section seal chamber using "O-Ring", or "VEE" packing, and allow the shaft seals to be replaced with the valve in line. Connect the shaft to the operating mechanism with accurate alignment.
 9. The valve shall be equipped with a traveling nut operating mechanism of the compound link/lever type, manufactured by the same manufacturer as the valve. The mechanism shall be attached rigidly to carry all torsional loads, prevent racking, and produce the required torque for the most adverse operating conditions specified. Provide a totally enclosed mechanism housing with removable cover, permanent lubrication, and shaft support outboard bearing to protect the shaft and shaft seals. Provide a mechanical valve position indicator, and allow for future installation of electronic indicating devices.
 10. Provide a water hydraulic actuator rigidly mounted on the operating mechanism, sized to operate the valve under the most adverse conditions specified. Provide each cylinder of heavy wall, seamless stainless steel tubing with piston of one piece construction, rod of stainless steel with hard chrome plating, gland cartridge of bronze, seals of Buna-N rubber. Provide heads and piston with chrome plating where in contact with water. Provide the actuator assembly as direct double acting and non-cushioned.
 11. Provide PLC (Programmable Logic Controller; Refer to SECTION 13322) based controls for the ball valves to have them function as pump control/check valves to minimize surges in accordance with the following sequence:
 - a) Pump start sequence activated. Ball valve closed position limit switch is activated indicating ball valve is fully closed allowing pump to start. Pump motor starter energized. Time delay (TDR) sequence activated.
 - b) Pump motor starts. Pressure switch (with adjustable set point) between pump discharge and ball valve, senses adequate pump discharge pressure and closes its electrical contacts energizing a four-way solenoid valve causing the ball valve to open at a predetermined rate. Rate of opening shall be manually adjustable from 30 seconds to three minutes for complete actuator travel. After the valve reaches approximately the five percent position, a closed position limit switch is deactivated opening a set of electrical contacts in the pump motor starter circuit preventing the pump from being started when the valve is in any position other than closed.
 - c) If ball valve open position limit switch is not activated in five minutes (field adjustable), indicating something is preventing the valve from reaching the fully opened position, then a time delay (TDR) times out and stops the pump with an appropriate alarm signal. If ball valve open position limit switch is activated within the set time delay period, the normal pumping sequence continues.
 - d) Normal pump stop sequence activated. Four-way solenoid valve is de-energized causing the ball valve to close at a predetermined rate, while the pump continues to run. Rate of closing shall be manually adjustable from 30 seconds to three minutes for complete actuator travel. Near the closed position, a limit switch is activated on the ball valve when

when the valve is approximately 95 percent closed interrupting power to the pump, thus stopping the pump causing the normally open two-way solenoid valve (B2A) to open causing the ball valve to close the remaining approximate five percent at the emergency close rate. The closed position limit switch must be activated to allow the pump to be restarted again.

- e) Emergency pump stop sequence is activated anytime a pump failure is indicated including power failure or other emergency interruption. Ball valve is in the fully open position, both the two-way and four-way solenoid valves are deactivated causing the ball valve to close at a faster than normal closing rate at a predetermined rate and shall be manually adjustable from 10 seconds to 30 seconds for complete valve actuator travel. This emergency pump stop sequence will ensure that the maximum amount of backflow from the returning water column resulting from column separation is shutoff as quickly as possible to minimize backflow to the pumping source and prevent potential damage to the pump from backspinning of the pump, yet slow enough to allow the ball valve to be partially open (approximately five percent) when the separated water column returns to the valve and hits the partially open ball valve discharging the air in the discharge line drawn in through the combination air release/vacuum valve and the water columns potential energy for surge and water hammer back through the partially open ball valve much like a surge anticipator valve, thus eliminating surge and water hammer.
12. At each ball valve a pressure-tapping device shall be provided for supplying water hydraulic operating pressure from each side of the ball valve in the pump discharge piping at the inlet and discharge side of each valve.
13. All solenoid valves shall be equipped with manual operators for manual operation without electrical power and position switches for Open/Close position monitoring.
14. Provide protective coatings for ferrous metal surfaces except for stainless steel in accordance with, epoxy coating per AWWA C-550 meeting NSF Standard 61, for surfaces in contact with water. Provide the exterior surfaces with two coats of alkyd primer.
15. Provide complete factory testing of the valves and operating system/controls including a body hydrostatic test to twice the valve's design pressure class, seat leakage test to not exceed 1 fl. oz./hr/in. diameter for five minutes minimum at the design pressure rating of the valve, and operating cycle test for three complete cycles. Submit certified test results to Contract Administrator, with copy to City Engineer, for the City Engineer's review prior to shipment.
16. Provide a hydro-pneumatic system to operate each valve through one closing stroke upon loss of power. Furnish a 106 gallon 30" diameter X 49" high pre-charged steel hydro-pneumatic tank with replaceable heavy-duty butyl rubber bladder. The tank shall have NPT system connections and a standard tire valve charging connection to facilitate the on-site charging of the tank to meet system requirements. The tank must be constructed and stamped in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code. The hydro-pneumatic system shall be complete with pressure gauge, pressure switch for remote mounting, and all operating controls.
17. Overall performance requirements for the ball valves:

No. of valves	3
Max. operating pressure	250 feet
Max. flow	4000 gpm
Valve size	Same as pump discharge
Service	Potable water, with up to 4 mg/L chloramine

	content
Operating mechanism	Water hydraulic cylinder actuation, supported by hydro-pneumatic system, adequate for one closing of one valve upon power failure.
Max. shutoff pressure	500 feet

2.08 GLOBE VALVES

- A. Bronze Valves. Valves shall be low-zinc bronze body type with tapered discs permitting close regulation of flow and conforming to ASTM 61 and MSS-SP-80. Valves shall be Class 125 with threaded ends. Valves shall be repackable under pressure when wide open. Valves shall be as manufactured by Lunkenheimer Figure 2140 or approved equal.
- B. PVC Valves. Valves shall be PVC body with FKM or EPDM seals and PVC disc with rising stem. There shall be no metal to media contact. All sizes rated for full vacuum service 29.9 "Hg. Valves shall have excellent flow regulating characteristics throughout the entire lift of the disc.
- C. Polypropylene Valves. Valves shall be polypropylene body with FKM or EPDM seals and polypropylene disc with rising stem. There shall be no metal to media contact. All sizes rated for full vacuum service 29.9 "Hg. Valves shall have excellent flow regulating characteristics throughout the entire lift of the disc.

2.09 CHECK VALVES

- A. Cast Iron Check Valves. Valves 3 inches and larger shall be flanged ANSI B16.1 end swing check valves, lever and weight operated for horizontal installation and outside spring for vertical installation, having cast-iron body and cover, renewable bronze seat, all bronze disc, bronze hinge, stainless steel hinge shaft and gate pins. The valves shall conform to AWWA C508. Cast-iron shall conform to ASTM Designation A 126. The valves shall be designed for low head loss, shall be adjustable for non-slamming closure, and shall be constructed to seat tight. An arrow showing direction of flow shall be cast on the body of the valve. The water working pressure shall be 200 psi maximum. The valves shall be as manufactured by American-Darling, 50 series or approved equal.
- B. Rubber Flapper Swing Check Valve. The rubber flapper swing check valve to be used on the water application shall have a heavily constructed cast iron body and cover. The body shall be long pattern design (not wafer), with integrally cast-on end flanges. The flapper shall be Buna-N having an "O" ring seating edge and be internally reinforced with steel. Flapper shall be captured between the body and the body cover in a manner to permit the flapper to flex from closed to full open position during flow through the valve. Flapper shall be easily removed without need to remove valve from line. Check valves shall have full pipe size flow area. Seating surface shall be on a 45° angle requiring the flapper to travel only 35° from closed to full open position, for minimum head loss and non-slam closure. The valve shall have a bottom buffer for free open and positive non-slam closing. The buffer shall be designed to contact the disc during the last 10% of closure and thereafter control the closure until the valve is shut off in a manner to minimize or prevent water hammer. The rate of closure shall be externally adjustable. Materials of construction shall be certified in writing to conform to ASTM specifications as follows:

- | | |
|-------------------|----------------------------------|
| 1. Body and Cover | Cast Iron |
| 2. Flapper | Buna-N |
| 3. Exterior Paint | In accordance with Section 09905 |

Valve shall be APCO series 100B rubber flapper swing check valve as manufactured Valve and Primer Corp., or preapproved equal.

- C. Bronze Check Valves. Valves three inches and smaller shall have bronze body and disc with screwed joints, and shall be swing check type to suit operating conditions. They shall conform to Federal Specifications WW-V-51F, Type IV, Class C. Design working pressure and an arrow showing direction of flow shall be cast on the body of the valve. The valves shall be as manufactured by Crane, No. 36 or approved equal.
- D. Thermoplastic Ball Check Valves. Thermoplastic ball check valves four inches and smaller shall have ASTM D1784, Type 1, Grade 1 polyvinyl chloride body with dual union socket weld ends, rated 150 psi at 75°F. Valves shall be equipped with Viton seats and seals and shall be as manufactured by Celanese Chemtrol or approved equal.
- E. HI-PVC Swing Check Valves. Valve shall conform to ASTM D1784 Cell Classification 12454A. Valves shall be PVC body with FKM, EPDM, or PTFE seals and shall incorporate a single disc design suitable for horizontal or vertical applications. Valves shall have a top entry bonnet for maintenance purposes. Valves shall be flat faced flanged end type conforming to ANSI B16.5 bolt pattern for 150 lb flanges.
- F. Polypropylene Swing Check Valves. Valves shall conform to ASTM D4101 Cell Classification PP0210B67272. Valves shall be polypropylene body with FKM, EPDM, or PTFE seals and shall incorporate a single disc design suitable for horizontal or vertical applications. Valves shall have a top entry bonnet for maintenance purposes. Valves shall be flat faced flanged end type conforming to ANSI B16.5 bolt pattern for 150 lb flanges.
- G. Polypropylene Ball Check Valves. Valves shall be true-union and single-union ball check valves and conform to ASTM D4101 Cell Classification PP0210B67272. Ball Check valves shall be polypropylene with EPDM, FKM or PTFE seals. Valves shall be of solid thermoplastic construction, and be designed with an elastomeric uniseat/seal for tight shut-off under pressure. Sizes 1/2" – 2" shall be true union, and sizes 3" & 4" shall be single union.
- H. The check valve manufacturer shall be responsible for providing and mounting the check valve position switches as shown on the Drawings and as specified to be compatible with the type of valve provided. Switches are to also be coordinated with the project Systems Integrator.

2.10. ECCENTRIC PLUG VALVES

- A. Valves shall be of the non-lubricated, eccentric type with resilient faced plugs. Flanges shall be faced and drilled in accordance with ANSI B16.1, Class 125. Mechanical joint ends shall conform to ANSI 21.11. Screwed ends shall conform to National Pipe Thread standards as required for correct jointing with connected piping. Grooved ends shall conform to AWWA C606. Port areas on valves 4-inch and larger shall be at least 87% of full pipe area. Drop tight shut-off shall be provided at full rated working pressure in the standard flow direction and 50 psi in reverse flow direction. An adjustable close position stop shall be provided for field adjustment. The seat end and standard flow direction shall be cast on the valve body. The shaft seal shall be the adjustable multiple V-ring type

multiple V-ring type or U-cup seal. All shaft seals shall be replaceable without disassembly of the valve. The plug shall be of a one piece design with a precision molded resilient facing. Resilient body seats are not acceptable. The resilient seating surface shall not be in the flow way pattern when the valve is in the open position. The body seating surface shall be welded nickel. Bearings shall be 316 stainless steel. Thrust bearings shall be provided in the upper and lower journal areas.

- B. Coating: The valve interior shall be fusion-bonded or 2-part thermal set epoxy coated per AWWA C-550. The exterior of the flanged and buried valves shall be coated per Section 09905.
- C. Valve shall be as manufactured by Dezurik or approved equal.

2.11 BUTTERFLY VALVES (RAW OR CONCENTRATE SERVICE)

- A. All butterfly valves shall be of the tight closing. The body and wetted parts shall be Super Duplex 20 ASTM A351. Valves ≤ 24 inches shall have RTFE Telfon valve seats. Each valve disc shall rotate 90° from the full open to the tight shut position. All valves shall be satisfactory for applications involving frequent operation, as well as for applications involving valve operation after long periods of inactivity. Any identifying serial number shall be stamped on a corrosion resistant plate attached to the valve body. Seat material shall be compatible for long term exposure to reverse osmosis concentrate waste with up to 15,000 mg/L chloride.
- B. Butterfly valves shall be the high performance, wafer style body ANSI 150#, with RTFE Telfon valve seat as manufactured by DeZURIK, Flowseal, ABZ Valves, or approved equal.

2.12 BUTTERFLY VALVES (FINISHED OR POTABLE WATER SERVICE)

- A. All butterfly valves shall be manufactured in conformance with and shall meet the requirements of AWWA Specification C504, "Standard for Rubber Seated Butterfly Valves," Class 200, except as modified herein. They shall be of the short- body type designed for the pressures required for Testing of Butterfly Valves. Country of origin shall be cast on the outside of the body and on the disc of each valve.
- B. All butterfly valves shall be of the tight closing, rubber seat type, valves smaller than 24 inches shall have rubber seats that are recess mounted and clamped on the disc, or otherwise, retained, in the valve body. Valves 24 inches and larger shall have seats capable of adjustment and replacement in the field without the removal of the valve from the line. Each valve disc shall rotate 90° from the full open to the tight shut position. Butterfly valves employing the use of a complete rubber lining on the inside of the valve body or on the face of flanges, or which requires an adjacent pipe flange for seat retention, shall not be acceptable. All valves shall be satisfactory for applications involving throttling service and/or frequent operation, as well as for applications involving valve operation after long periods of inactivity. Any identifying serial number shall be stamped on a corrosion resistant plate attached to the valve body.
- C. Butterfly valves shall be the Rubber Seat Butterfly Valve as manufactured by DMB/KFlo, Dezurik, Henry Pratt Company, or Rodney Hunt, without exception.
- D. Valve Bodies and Flanges: All valve bodies shall be constructed of ductile iron in strict conformance with "Standard Specification for Gray Ductile Castings," ASTM Designation: A 536, Grade 65-45-12. The minimum body shell thickness shall strictly conform to the Specifications given in Table 2 of AWWA Specification C504. The valve shall have flanged ends, faced and drilled and spot faced on the back side. All flanges shall be rated for 250 pound working pressure

working pressure and drilled to match ANSI B16.1 Class 250 flanges. The flanged ends and trunnions for shaft bearings shall be integral with each valve body.

1. Body Stops. The use of a stop or lug cast integrally with or mechanically secured to the body for the purpose of limiting disc travel by means of direct contact or interference with the valve disc (in either the open or closed position) will not be acceptable.
 2. Flanges. Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch. The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot [0.017 percent] of flange diameter.
- E. Valve Discs: Valve discs shall be of ductile iron, in strict conformance with "Standard Specification for Ductile Iron Castings," ASTM Designation: A536, Grade 65-45-12. When the rubber seat is located on the valve body, the mating disc seating surface shall be 18-8 Type 316 stainless steel or Monel. All discs shall provide 360 degrees seating and, if of a design requiring stiffeners or supports outside the disc proper, such support vanes shall be integrally cast. The interior of the fabricated valve discs shall be ribbed.
- F. Valve Shafts: Shafts of all valves shall be turned, ground, and polished Type 304 or 316 stainless steel. Valve shafts shall extend full-sized through the valve disc and valve bearings. Shaft seals shall be either o-rings contained in a removable corrosion-resistant housing, or chevron type. Shafts with hexagonal cross section will not be acceptable.

The connection between the shaft and the disc shall be mechanically secured by means of solid, smooth sided, stainless steel or monel taper pins or dowel pins. Each taper pin or dowel pin shall extend through or shall wedge against the side of the shaft and shall be mechanically secured in place. The use of bolts, setscrews, knurled or fluted dowel pins, expansion pins, roll pins, tension pins, spring pins, or other devices instead of the pins specified herein will not be acceptable.

- G. Valve Seats: Valve seats shall be of synthetic rubber such as Buna-N. Valves manufactured with seats recess mounted in the disc shall employ Type 304 or 316 stainless steel (monel or plasma applied nickel chrome overlay also acceptable) retaining segments, held in place by adjustable 18-8 stainless steel clamping screws, to provide complete immobility of the seat under all operating conditions. For valves manufactured with the seat in the body of the valve, the seat shall be bonded, clamped and/or mechanically retained, to the valve body to provide complete immobility of the seat under all operating conditions and to prevent passage of water or build up of pressure under the rubber seat. The mating seat surfaces shall be of monel or plasma applied nickel chrome, or Type 304 or 316 stainless steel when the rubber seat is on the valve disc. The seat shall be of such design as to allow the valve disc to seat at an angle of 90° to the pipe line axis at the fully closed position. Valve seats that extend over or onto the face of the flanges, or that require surface grinding and/or hand fitting of the disc edge shall not be acceptable.
1. Seat design shall permit adjustment and replacement of seats without removing the valve from the line.
- H. Valve Bearings: The valves shall be fitted with sleeve-type bearings contained in the bearing trunnions of the valve body. Bearings shall be self-lubricated and constructed of bronze impregnated with a silicone oil for air service at 300°F; or for other service nylon bearings; or of a fine rayon fabric wound on a mandril, with an epoxy resin binder to develop the required outside diameter and lined with a minimum thickness of one thirty-second (1/32) inch of teflon or of fiberglass backed teflon. Bearings shall be force-fitted into the bearing journal. The rayon/teflon bearings shall be as manufactured by Rex Chainbelt, Inc., Fafnir, or equal. In addition to the shaft

bearings, each 24-inch and larger valve shall be equipped with an adjustable thrust bearing, which shall be totally enclosed and protected, and which shall be set and locked to hold the valve disc and shaft assembly securely in the center of the valve seat. Valves designed for shaft connection to an operator shall be provided with a shaft bearing beyond the stuffing box gland. The housing for this bearing shall be rigidly attached to the valve body, or may be fitted into the valve operator assembly, which in turn shall be rigidly attached to the valve body.

- I. Stuffing Box Access: Except for buried valves, all valves shall have access openings to the stuffing box to permit repacking of the valve without removal of the operator. Valves shall be fitted with self-adjusting split-V type packing.
 - 1. All manually operated valves shall be equipped with mechanical, adjustable stops to govern the degree of rotation of the valve disc.
- J. Valve Operators in General: Valve operators shall be designed in strict accordance with the requirements of A.W.W.A. Specification C 504-87 and Appendix, except as modified herein, and shall furnish sufficient torque to open and close each valve at 125 percent of the rated working pressure for the valve.
 - 1. The valve operators shall be sized to hold the valve disc in the fully open position, any intermediate position, and the fully closed position without creeping or fluttering.
 - 2. The valve operators shall be provided with a totally enclosed, properly lubricated disc actuator of the worm gear type.
 - 3. Gear operators shall have an adjustable stop for the open and closed position, and, except on units for buried service, shall have a valve disc position indicator. Manual operators shall be equipped with extension stems and operating nuts, handwheels, chain wheels, floor stands, floor boxes and stem pipe as required.
 - 4. Actuators composed of worm gearing shall have worm gears of bronze and worms of hardened steel.
 - 5. For valves 4-inches and smaller, located above ground, the valve operator shall be the locking lever handle type. The operator shall be designed for a maximum pull of forty (40) pounds on the lever handle. The valve operator shall be designed to hold the valve disc in the fully open position, any intermediate position, and the fully closed position without creeping or fluttering.
- K. Manual Operators: Manually operated butterfly valves, shall be installed where indicated on the drawings and shall be equipped with handwheels where they are installed above grade and with operating nuts per AWWA C500 where they are buried as required, disc position indicators, and shall open by turning to the left (counterclockwise). They shall be installed in the positions shown on the drawings or as ordered. Manual operators shall be so proportioned as to permit operation of the valves under full operating head with a maximum pull of forty (40) pounds on the handwheel. The valve operators shall have adjustable stops (not in the valve body) and, as an additional precaution, handwheel or wrench operated valves shall be equipped with a manually operated locking device to prevent disc creeping.

Actuators shall withstand, without damage, an input torque of 300 ft. lbs. for operating units, at extreme actuator positions. Actuators shall permit operation with a maximum input torque of 150 ft. lbs. for operating units at full rated pressure.

- L. Coatings: Butterfly valve coatings shall conform to the following (Section 09905 does not apply to this particular valve):

Shop Coatings

Medium Consistency Coal Tar	Carboline "Kop-Coat Bitumastic Super Service Black" or Tnemec "46-465 H.B. Tnemecol".
Epoxy Enamel	NSF certified systems; Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Kop-Coat Super Hi Gard 891", or Tnemec "Series 140 Pota-Pox Plus"; immersion service.

All interior and exterior ferrous metal surfaces, except finished surfaces, bearing surfaces, and stainless steel components, of valves and accessories shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable.

The following surfaces shall be painted:

Unfinished Surfaces	
Interior Surfaces	Epoxy enamel.
Exterior Surfaces	Medium consistency coal tar.
Polished or Machined Surfaces	
Flange Faces	Rust-preventive compound.
Other Surfaces	Epoxy enamel.

Interior coatings shall comply with AWWA C550 and shall be free of holidays.

The total dry film thickness of shop-applied coatings shall be not less than:

<u>Type of Coating</u>	<u>Minimum Dry Film Thickness</u>
Medium Consistency Coal Tar	6 mils
Epoxy Enamel	12 mils
Rust-Inhibitive Primer	3 mils

2.13 BUTTERFLY VALVE ELECTRIC OPERATORS

- A. Electric valve actuators shall include the motor, actuator unit gearing, limit switch gearing, position limit switches, stem nut, declutch lever and handwheel as a self contained unit. The actuator shall be in strict conformance with the latest revision of the AWWA C540 Specification. For all buried valves the operator shall be located above grade with extended bonnets 48-inches above final grade.
- B. The valve travel time from full open to full close or from full close to full open shall be between eight (8) and fifteen (15) minutes.
- C. Motor: The motor shall operate from 460 VAC, 3 phase service. The motor shall be specifically designed for valve actuator service and shall be of high starting torque, totally enclosed, non-ventilated construction. The motor insulation shall be a minimum NEMA Class F, with a maximum continuous temperature rating of 155 degrees C (rise plus ambient) for the duty cycle specified.

1. The motor shall be of sufficient size to open or close the valve at the maximum required torque. The motor shall be capable of operating at plus or minus 10% of specified voltage. The motor duty rating shall be sufficient for one complete cycle, starting in the closed position (open-close-open, or reverse), without exceeding its temperature rating. Motor bearings shall be of the anti-friction type, and permanently lubricated.
 2. The motor shall be an independent sub-assembly such that the power gearing shall not be an integral part of the motor assembly, to allow for motor or gear changes dictated by system operation requirements.
 3. The motor shall be equipped with internal thermal contacts to protect against motor overload and 120 volt AC heaters.
 4. Included as a part of the valve actuator assembly shall be the motor starters.
- D. Power Gearing. The actuator shall be a multiple reduction unit with power gearing consisting of spur, helical, bevel, and/or worm gearing. There shall be a self-locking worm gear set in the drive train to maintain valve position. The spur or helical gearing and worm shall be of hardened alloy steel, and the worm gear shall be alloy bronze. All power gearing shall be accurately cut. Non-metallic, aluminum or cast gearing shall not be allowed. Anti-friction bearings with caged balls or rollers shall be used throughout.
- E. Lubrication. All rotating power train components shall be immersed in grease with provisions for inspection and re-lubrication without disassembly. Lubricants shall be suitable for ambient conditions of minus 20 degrees F to 150 degrees F. Adequate seals shall be provided on all shafting.
- F. Self-Locking Feature: Actuator gearing and/or stem threading shall be self-locking.
- G. Lost Motion Device: The actuator shall have a build in device, incorporated in the power train and located between the worm gear and actuator drive sleeve, to permit load impact under dynamic efficiency conditions, with a hammer blow effect, to allow the motor to reach full speed before engaging the valve load.
- H. Manual Operation: A metallic handwheel shall be provided for manual operation with an arrow to indicate "open" rotation. The handwheel shall not rotate during motor operation. Fused motor shall not prevent manual operation. When in the manual operating mode, the actuator shall remain in this mode until the motor is energized, at which time the actuator will automatically return to electric operation. Movement from motor operation to handwheel operation shall be accomplished by a positive pad lockable declutch level which mechanically disengages the motor and related gearing. The unit shall be designed such that it is impossible for simultaneous manual and motor operation to occur. Friction type declutch mechanisms shall not be acceptable.
- I. Stem Nut: The valve actuator shall have a removable stem nut (or drive bushing) of high tensile bronze or other material compatible with the valve stem material.
- J. Position Limit Switches: Position limit switches and the associated gearing shall be an integral part of the valve actuator. Limit switch gearing shall be of the intermittent type, made of bronze or stainless steel, grease lubricated, and totally enclosed to prevent dirt and foreign matter from entering the gear train. Switches shall be adjustable, allowing for trip points from fully open to fully closed positions of valve travel. They shall not be subject to breakage or slippage due to over-travel. Limit switch contacts shall be heavy duty, silver plated. The actuators shall have four (4) contacts, all of the same basic design. Contacts shall be convertible from normally open to normally closed or

normally closed or reverse. Switch design shall permit visual verification of switch position without disassembly.

1. The electric actuator shall be equipped with a dial position indicator that shall show valve position continuously throughout the full range of valve travel.
- K. Torque Switch: Each valve actuator shall be equipped with an adjustable switch, that will interrupt the control circuit in both the opening and closing direction when valve torque overload occurs or when valve requires torque seating in the close or open position. Contacts shall be silver plated. The torque switch shall have graduated dials for both open and close directions of travel and each shall be independently adjustable, with a positive means to limit the adjustability so as not to exceed the actuator output torque capability. Switch design shall permit visible verification of switch position without disassembly. Torque switch shall be factory calibrated to indicate 100% output torque within $\pm 3\%$.
- L. Switch Contact Ratings: The position limit switch and torque switch shall be rated 600 volts per NEMA standard ICS 2-125, heavy duty and shall bear a UL label.
- M. Control Compartment Heater: The control compartment shall be provided with a space heater.
- N. Local/Remote Modes of Operation: The City shall be able to reposition the actuator by moving the built-in local/remote pad lockable selector switch to the local mode and then depressing the built-in open/close push buttons. In the remote mode, the valve actuator shall open and close via external relay contacts.
- O. Service Conditions: The controller shall be designed and constructed to operate within the following service conditions:
1. Elevation: To 3300 Feet.
 2. Ambient Temperature Range: 0 C to 40 C.
 3. Atmosphere: Non-Condensing relative humidity to 95%.
 4. AC Line Voltage Variation: -10% to +10%.
 5. AC Line Frequency Variation: ± 3 Hertz.
- P. Enclosure: All valve operator components shall be factory mounted and wired on a grounded enclosure. The Enclosure shall be NEMA 4. The terminal enclosure shall be double seal protecting internal controls from ingress of water via the conduit.
- Q. Warranty: The valve operators shall have a one year warranty on all parts.
- R. Acceptable Manufacturers: Product that are specified by manufacturer, trade name or catalog number establish a standard of quality. Substitution of equal manufacturers shall not be allowed unless specifically stated herein, and shall be subject to favorable review by the City Engineer.
1. For purposes of standardization, the valve operators shall be LY Series as manufactured by Limitorque Corporation, 5114 Woodall Road, Lynchburg, Virginia, 24506.
 2. Companies supplying other than the named equipment shall also supply:
 - a. One (1) week of on site start-up and debugging time at no additional cost. A factory-trained technician shall be available on site within one (1) week's notice from City;

- b. For each valve supplied four (4) complete sets of repair/replacement parts required for any “owner maintenance” items described in the standard product operation and maintenance manuals supplied with the equipment;
- c. In the event that the valve operator has any sealed units (electronics) and has no “owner maintainable parts,” then the warranty shall include: parts, labor, and shipping to return the device for repair and be extended to five (5) years;
- d. Three (3) weeks of training by a factory-trained engineer or technician for three of City’s technicians. This training shall include component level troubleshooting and software. This training shall be provided at no additional cost to the City.

2.14 FLAPPER VALVE

- A. Valve shall be of the flow operated check type with a slip-on connection. Inlet port area shall be 100% of the mating pipe port size. The port area shall contour down to a duckbill which shall allow passage of flow in one direction while preventing reverse flow. The valve shall slip on over the pipe outside diameter as shown on the drawings.
- B. The flexible duckbill sleeve shall be one piece neoprene rubber construction with fabric reinforcement. The check valve shall also have a protective EPDM exterior wrapping for protection against ultraviolet attack. Check valve shall be attached to the pipe outside diameter by means of manufacturer-furnished stainless steel clamps.
- C. Valve shall be designed to operate over a line pressure range of one foot NGVD.
- D. Valve shall be Series TF-2 as manufactured by Red Valve Co., Inc., Pittsburgh, PA, or approved equal.

2.15 COMBINATION AIR RELEASE VALVES (ARV)

- A. The combination ARV consists of two types of air release valves, one to allow trapped air to escape and the other to exhaust large quantities of air during filling.
- B. The automatic air release valve shall be designed to operate under a test pressure of 150 psi, and to allow trapped air to escape from high points of a pipeline, pump, tank, or water system. After the air escapes out of the air release valve through the orifice the valve shall close to prevent water from escaping. The air release valve will then stay closed until more air accumulates in it and the opening cycles will be repeated automatically. The air release valve shall have a stainless steel float. Where air release valves are shown on the drawings, the automatic valve shall be accompanied by an APCO Series 140 valve designed to exhaust large quantities of air during pipe filling operations.

- C. All materials of construction shall be certified in writing to conform to ASTM specifications as follows:

Body & Cover - cast iron	ASTM A48 Class 30 or ASTM A126, Gr.B.
Internal bronze parts	ASTM B143
Stainless float	ASTM A240
Seat	Buna-N

- D. Valves shall be as manufactured by APCO Series 200A and 140, or approved equal. Inlet and orifice sizes shall be as shown on the drawings. Orifice sizes shall be a maximum of 3/16-inch for the 200A.

2.16 AIR/VACUUM VALVES

- A. The slow closing air and vacuum valve shall be three (3) or four (4) valves furnished, assembled, and tested as a single unit, with the 3 valve unit used for buried pipe, and the 4 valve unit for exposed pipe. The air and vacuum valve must have a stainless steel float guided at each end with stainless stems. The stems shall be guided through stainless steel bushings inside the body and cover. The seat must be Buna-N fastened to the cover with stainless shoulder screws without distortion to allow drop tight closure. The cover shall have a male lip to fit the female body register for positive float guide direction into the seat. Cover outlets shall be flanged.
- B. The surge check valve shall be a normally open spring loaded valve consisting of a body, seat and plug bolted to the inlet of the air and vacuum valve. The surge check shall operate on the interphase between the kinetic energy and relative velocity flows of air and water, allowing air to pass through but water shall close the surge check, reducing the rate of water flow by means of throttling orifices in the plug to prevent shock closure of the air and vacuum valve. The surge check orifices must be adjustable type to suite operating conditions in the field.
- C. The inlet isolation butterfly valve (used for exposed pipe only) shall be wafer (compact) style constructed to AWWA Standards with hand level and variable position locking device. The seat to be freely interchangeable from the body without need for special tools or skill. The seat must be Buna-N, molded with a steel flanged insert for high strength and tight seating. The disc must pivot eccentrically from closed position to clear center valve area.
- D. The air release valve shall be side connected to the upper valve, but separated with a bronze isolation shut-off valve. The internal mechanism shall be the compound lever type to permit the valve to open under pressure to vent pockets of entrapped air as they accumulate. The compound mechanism shall be activated by a stainless steel concave float to lift the Buna-N needle to shut-off the Air Release orifice.
- E. The slow closing air and vacuum valve shall have been flow tested in the field, substantially by test data to show reduction of surge pressure in the valve.
- F. Materials shall be certified to A.S.T.M. specifications:

A&VV/ARV covers, bodies

Surge check body and BFV body	Cast iron	ASTM A126 GR.B
Floats & spring	Stainless steel	ASTM A240
Surge check seat & disc	Bronze	ASTM B584
ARV Needle	Buna-N	
Air & Vacuum Valve Seat	Buna-N	
Leverage assembly	Delrin	ASTM D2133
B.F.V. shaft	Stainless steel	ASTM A270
Exterior paint	Phenolic Primer Red Oxide	FDA Approved for Potable Water Contact

- G. Valve shall be APCO Series 1200 (for exposed pipe) and Series 1700 (for buried pipe) Slow Closing Air and Vacuum Valve as manufactured by Valve & Primer Corp., Schaumburg, Illinois, U.S.A.

2.17 SEWAGE AIR RELEASE VALVES

- A. The automatic air release valve shall be designed to operate under a test pressure of 125 psi, and to allow trapped air to escape from a sewage pipeline. After the air escapes out of the air release valve through the orifice, the valve shall close to prevent water from escaping. The air release valve will then stay closed until more air accumulates in it and the opening cycles will be repeated automatically. The air release valve shall have a stainless steel float.
- B. All materials of construction shall be certified in writing to conform to ASTM specifications as follows:
- | | |
|--------------------------|-------------------|
| Body & Cover – cast iron | ASTM A48 Class 30 |
| Internal bronze parts | ASTM B143 |
| Stainless float | ASTM A240 |
| BUNA-N | Nitrile rubber |
- C. Sewage air release valves shall be as manufactured by APCO Series 400, or approved equal. Inlet and orifice sizes shall be as shown on the drawings.

2.18 BACKFLOW PREVENTERS

- A. All back flow preventers required by these specifications or shown on the drawings shall be the reduced pressure type, unless shown otherwise and shall consist of two spring loaded check valves and one differential relief valve. Valves shall be supplied with inlet and outlet shut off valves, ball valves on small diameter and gate valves on large diameter conforming to previous specifications. The valves shall conform to the requirements of the United States Public Health Service and shall comply with all provisions of AWWA C506. Valves shall be, or equal to, those shown in the following schedule:

<u>Pipe Size</u>	<u>Reduced Pressure Preventer Manufacturer and Model</u>	<u>Double Check Valve Preventer Manufacturer and Model</u>
3/4" through 2"	Hersey Model FRP II with bronze body	Hersey Model FDC
2-1/2" through 10"	Hersey Model 6CM with epoxy coated cast-iron	Hersey Model No. 2

2.19 FLOOR DRAINS

- A. Floor drains shall be as shown on the drawings.
- B. Floor drains shall be Josam Series 30000-A, type 8A or approved equal having cast iron body (unless otherwise specified), bronze top, perforated stainless steel basket, and hub outlet with gasket.

2.20 CLEAN OUTS

- A. Clean outs shall be as shown on the drawings and shall be Josam Series 56000 or approved equal for

for interior installations having cast-iron body, adjustable housing, threaded bronze plug, and hub outlet with gasket. Exterior installation cleanouts shall be Josam series 58490 or approved equal having C.I. Body with bronze plug.

2.21 SERVICE SADDLES

- A. Saddles shall be as manufactured by Smith-Blair, Inc. or approved equal. Units for cast or ductile iron pipe shall be double strap, ductile iron, Type 313, and for plastic pipe, Types 342 or 352, as applicable. Sealing gaskets shall be suitable for the applicable service and straps shall be corrosion resistant alloy or stainless steel.

2.22 CURB AND CORPORATION STOPS

- A. Units shall be brass, equipped with connections compatible with the connecting service pipe type, in accordance with AWWA Standard C800.

2.23 SMALL DIAMETER ISOLATING VALVES

- A. Provide all small diameter valves and cocks for shutting off process connections to instrumentation and other miscellaneous uses. These shall be metal (bronze) ball valves of the same material and pressure rating as the adjacent process piping. Shutoff valves to instrumentation shall be coordinated with Division 13 and shall be not less than 1/2-inch NPT unless otherwise specified.

2.24 HOSE RACK AND HOSES

- A. Each wall hydrant, as shown on the drawings, shall be equipped with a 50-foot length of rugged, flexible, minimum four-ply abrasion resistant wrapped rubber hose, having a minimum 3/4-inch inside diameter complete with securely attached male and female short shank brass threaded couplings. Each hose assembly shall have a heavy-duty insulated spray gun (McMaster Carr Model 7433T53, or approved equal, attached with appropriate couplings. Minimum working pressure shall be 150 psi. Hose Rack shall be in accordance with Detail 4 and Sheet M-0.02.

2.25 STRAINERS (GENERAL PURPOSE)

- A. Wye strainers and basket strainers shall be installed where indicated and as specified herein. Strainers shall be Heyward Model 80 or approved equal. Strainers shall be suitable for 125 pounds per square inch working pressure and shall have cast iron bodies unless otherwise specified. Strainers shall be furnished with Type 316 stainless steel baskets with 1/32-inch perforations. Pressure drop through strainers shall not exceed 1.0 psi at a flow velocity of 3.0 fps in adjoining piping. All strainers shall be provided with an isolation plug cock installed on the flushing port.

2.26 QUICK CONNECT COUPLINGS

- A. Quick couplings shall be of glass fiber reinforced polypropylene and shall be supplied as the male or female connections as shown on the drawings. Couplings shall be furnished with Type 304 stainless steel levers and pins and EPDM gaskets. Each coupling shall be supplied with a glass fiber reinforced polypropylene dust plug or dust cap attached to the coupling with Type 304 stainless steel chain.

2.27 FIRE HYDRANTS (POTABLE WATER)

- A. General. Hydrants shall comply with AWWA Standard C-502, "Fire Hydrants for Ordinary Water Works Service," and shall be equipped with a minimum of one pumper outlet nozzle 4½-inch in diameter and two hose nozzles 2½-inch in diameter.
- B. Units shall be traffic type with breakable safety clips or flange and stem, with safety coupling located below barrel breakline to preclude valve opening.
- C. Outlet nozzles shall be on the same plane, with minimum distance of 18 inches from center of nozzles to ground line. Valve shall be compression type with 5¼-inch minimum opening and shoe inlet connection to be 6 inches maximum. Hydrants shall be of the non-draining type as manufactured by Kennedy or approved equal.
- D. Installation. Hydrants shall be installed plumb and in true alignment with the connecting pipes to the water main. They shall be securely braced against the end of the trench (undisturbed soil) with concrete thrust blocks or City Engineer approved restrained joint assemblies.

2.28 SELF-CONTAINED PRESSURE CONTROL VALVES

- A. Pressure control valves shall be of the spring-loaded, self-contained type. The valves shall be for regulating back pressure or discharge pressure as shown on the drawings. Wetted materials shall be entirely suitable for the process fluid. The body shall be bronze unless specified otherwise. The pressure control valves shall be as manufactured by Fisher Controls, GA Industries, or approved equal. End connections shall be as shown on the drawings.

2.29 STATIC MIXER

- A. The static mixer shall function efficiently. The static mixer shall incorporate tabular mixing arrays, which shall induce high efficiency mixing vortices and which are monolithically molded as part of the housing wall.
- B. The static mixer shall incorporate the required number of tabular arrays to provide complete mixing at all design conditions.
- C. The static mixer shall incorporate FRP materials, construction methods, and workmanship equal to or in excess of that required by NBS Voluntary Standard PS-1569. For sulfuric acid, assure compatibility of materials with the 98% concentrated acid.

The projected area of the mixing elements, in the plane perpendicular to the mainstream flow, can not exceed 1.0 percent of the total cross sectional area.

At no point may any components of an individual element or adjacent elements intersect or come in direct contact with one another.

- D. Each mixing element must be attached directly to the housing wall and cannot rely on adjacent elements, rods, retaining grates, fasteners, or any other device for retention within the mixer housing. Flanges shall be molded as an integral part of the mixer housing.

Vendor must establish compliance with mixer performance criteria by providing independent test data confirming uniformity and pressure drop in a similar flow regime and similar line size.

2.30 PRESSURE RELIEF VALVES

- A. The pressure relief valves to be installed on the high service pump station header shall be hydraulically operated, pilot controlled, modulating globe style valve designed to maintain upstream pressure within close limits. It is intended for use as a pressure relief valve in this application to relieve pressure above 190 psi.
- B. The valve shall be Cla-val Model 50-01, or approved equal.
- C. Valve Body: Ductile Iron, ASTM A-536, Flanges per ANSI B16.42, 300 lb.
Disc retainer and diaphragm washer: Cast Iron
Trim: Stainless steel
Disc: Buna N
Diaphragm: Nylon reinforced Buna N rubber
Stem, Nut, and Spring: Stainless Steel
Adjustment range 100 to 300 psi
Pilot system materials, stainless steel and Buna N
- D. For the chlorine contact facility, provide 8-inch angle style pressure relief valves, with the pressure relief set at 20 psig. Adjustment range 10-50 psig. CLA-VAL 50-01 or approved equal. Materials identical to Paragraph 2.28 C. above.

2.31 V-PORT BALL VALVES

- A. The V-port ball valves shall be designed for throttling application to maintain both upstream pressure and regulate the flow split to the aerators and or aerator bypass. Full port model(12 inch diameter) shall be provided for each aerator, and standard port for the bypass(20 inch). Flanged body construction shall utilize Class 150 flanges. Body materials shall be 316 stainless steel, per ASTM A743, Grade CF8M. Valves shall be provided with corrosion resistant bearings compatible with the near potable quality groundwater that has its pH reduced to approximately pH 5.5 after sulfuric acid injection. Standard temperature packing shall be provided with stainless steel packing glands. Ball material shall be stainless steel with a hard chrome face, compatible with the service described above. Ball design shall include a V shape on both edges of the ball allowing control action to be reversed without disassembly of the valve or removal of the actuator. Provide solid 316 stainless steel seat with No. 12 Stellite.
- B. Valves shall be DeZurik VPB-Maxum V-Port Ball Valves, or approved equal
- C. The valves shall be provided with electric actuators in accordance with Paragraph 2.03 of this specification section.
- D. Valves shall operate properly in the following ranges without cavitation or other damage:
Aerator valves-6 mgd maximum hydraulic capacity, 2 mgd minimum
Maximum pressure drop across valve 70 psi, and maximum upstream pressure of 100 psi.
Minimum upstream pressure-100 feet NGVD.
Bypass valve- 15 mgd maximum hydraulic capacity, 2 mgd minimum

Maximum upstream pressure 100 psi, maximum pressure drop across the valve, approximately 75 psi.

Minimum upstream pressure-100 feet NGVD.

2.32 ATMOSPHERIC VACUUM BREAKER

- A. All atmospheric vacuum breakers for plumbing at each potable hose valve shall be Model 710 as manufactured by Febco, or equal. Bodies and bonnets shall be all bronze with molded plastic or a high boyance material poppets. Unit to operate without any spillage. Unit to be rated at 150 psi working pressure and shall withstand 110°F water temperature. Vacuum breaker to be installed per detail or where indicated on drawings.

2.33 PRESSURE REDUCING VALVES

- A. The pressure reducing valves at the potable water metering stations shall reduce a higher inlet pressure to a constant lower outlet pressure. For the 1-inch potable water and sample piping connected to the high service pump station discharge, provide a low flow bypass feature.
- B. Valves shall be Watts Series 115 Globe style, equivalent by Cla-Val Model 90-01, Model 90-48 for low flow bypass, or approved equal.
- C. Body and Cover: Cast Iron. ASTM A126 Class B
Seat and Retainer Plate: Stainless Steel, AISI 303
Internals: Brass, ASTM B584, Alloy 84400, or Ductile Iron, fused epoxy coated, ASTM A536, Gr. 60-40-18
Stem and Spring: Stainless Steel AISI 303
Elastomers: Diaphragm Nylon reinforced Buna N
Seat Seal: Buna N
Pilot controls: Brass Body, Stainless Steel internals, Buna N elastomer
250 lb flanges, ANSI B16.1

2.34 VALVE TAGS

- A. All valves shall be provided with a valve tag heavily stamped or engraved to duplicate the valve symbols shown on the P&ID drawings. The tags shall conform to the requirements of Section 11001. Valve tags shall be secured to exposed valves with 18 gauge type 304 stainless steel wire or stainless steel chain through a hole in the tag. Four-inch brass valve tags for buried valves shall be cast permanently into the concrete collar around the valve box or extended bonnet. In addition to the valve symbol, the valve type, process fluid, direction to open and number of turns to open shall be engraved on the tags. Anchoring of tags into concrete after casting shall not be permitted.

2.35 VALVE AND OPERATOR SCHEDULE

- A. Valves shall be of the type specified in the Valve Schedule, Table 1 unless shown otherwise on the drawings. Motor operated valves shall be of the type specified on the drawings. All valves and motor operators of the same type shall be of the same make unless otherwise approved and shall be as specified herein.

2.36 YARD HYDRANTS

- A. Wet and dry pit yard hydrant. The inner or wet pit connects the brass nozzle coupling with the valve plunger, affording unrestricted passage of water to the brass nozzle outlet.
- B. Plunger operates up and down without torsional strain. When water is admitted into valve, the dry outlet is completely sealed by the water on the plunger.
- C. Material of construction:
 - 1. Barrel: Ductile Iron.
 - 2. Working Parts: Brass
- D. Depth of Bury - 4 feet.
- E. Positive Automatic Drain.
- F. Inlet and Outlet size: 1-inch diameter, provide 2 x 7 reducer for inlet.
- G. Provide one hundred foot-length of rugged, flexible, minimum four-ply abrasion resilient wrapped rubber hose, having a minimum 1-inch inside diameter complete with securely attached male and female short shank brass threaded coupling for each yard hydrant. Provide a spray gun similar to Paragraph 2.22, A. for each yard hydrant assembly.
- H. Provide an 8"x8" x 8'-0" long precast concrete post embedded in ground 4'-0" adjacent to each yard hydrant for mounting a hose rack provided in and mounted in accordance to Detail 4 on Sheet M-0.02.
- J. All yard hydrants shall be equipped with an automatic vacuum breaker.
- K. Manufacturer and Model: The Kupferle Foundry Company, Eclipse No. 1, or approved equal.

2.37 PINCH VALVES

- A. Pinch valves are to be of the full cast metal body, mechanical pinch type with flange joint ends on both the body and the sleeve trim. The valve shall have face-to-face dimensions of standard gate valves, in accordance with ANSI B16.10 up to 12" size. Sizes 14" and larger shall have a face to face dimension no longer than twice the nominal valve port diameter. The flanges shall be drilled to mate with ANSI B16.1, Class 125/ANSI B16.5, and Class 150 flanges.
- B. The sleeve trim shall be one piece construction with integral flanges drilled to be retained by the flange bolts. The sleeve trim shall be reinforced with calendared nylon or calendared polyester fabric to match service conditions. The sleeve trim shall be connected to the pinch bar by tabs imbedded in the sleeve trim-reinforcing ply. All internal valve metal parts are to be completely isolated from the process fluid by the sleeve trim.
- C. For full port and reduced port sleeves, the port areas shall be 100% of the full pipe area at the valve ends. For Cone and Variable Orifice sleeves the inlet port area shall be 100% of the full pipe area, reducing to a smaller port at the outlet.
- D. The steel mechanism shall be double acting with pinching of the sleeve trim occurring equally from two sides. ACME threads shall be used on all valve mechanisms. There shall be no cast parts in the operating mechanism. The stem shall be non-rising and have a non-rising handwheel. The handwheel shall be constructed of welded, tubular steel and be connected to the stem by means of a

a single retaining bolt. The handwheel shall be fitted with a lubrication fitting to allow lubrication of the stem. A valve position indicator rod shall pass through the center of the stem, retaining bolt, and handwheel to provide visual position indication. Bevel gear operators shall be provided on all valves over 8" size. Lifting eyelets shall be provided on the top of the valve body where applicable.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall be in conformance with Section 15060 and the following requirements.
1. Valves, valve boxes, and extended operators shall be set in true alignment and grade in accordance with the procedures submitted with the shop and erection drawings, and the valves mounted as shown. All adjustments and operating settings of valves and appurtenances shall be made in accordance with procedures and detailed instructions furnished with the erection drawings. All valve boxes and extended bonnets shall have a concrete collar cast around the box or bonnet once it has been set at proper grade. All valve stem extensions will be pinned on during construction.
 2. Buried valves shall be firmly supported in place by the foundations to preclude strain on the pipe connections. The valve boxes shall be checked for centering plumb over the wrench nut to ensure that the box cover is flush with the finished grade. Earth backfill shall be carefully tamped around each valve box to a distance of four feet on all sides of the box, or to undisturbed trench face if less than four feet. Valves shall have their interiors cleaned of all foreign matter before installation. The valves shall be inspected in opened and closed positions to ensure that all parts are in working condition.
 3. Aboveground valves shall be rigidly held in place using supports and hangers as shown on the drawings and as specified. The stem orientation of valves in elevated piping shall be as approved by the City Engineer for accessibility, but no valve shall have stem in the downward direction. Saddle type valve supports shall be provided for all valves in vaults. Supports shall be of rugged construction providing at least 120 degrees under support for the valve body, shall be constructed of steel as specified in Division 5, and shall be anchored to the foundations using 316 S.S. anchor bolts.
 4. Float valves shall be installed in strict accordance with the manufacturer's instructions. A maximum 2-inch adjustment range will be applied between fully open and fully closed valves. The valve on the groundwater line will be fully closed when the water level is 1 inch below the full open position of the desal line.

3.02 PROTECTIVE COATINGS

- A. All interior non-working ferrous surfaces other than stainless steel, and all exterior ferrous surfaces other than stainless steel shall be given protective coatings. Unless otherwise specifically modified herein, the coatings shall conform to the provisions of Section 09905, "Painting and Protective Coatings" (except AWWA Butterfly Valves) for preparation of surfaces, coating materials, application, and dry film thickness. The interior waterway passages of all valves shall be given a shop applied coating system (per AWWA C550 for AWWA Butterfly Valves) unless provided with a fusion bonded epoxy coating. The exterior surfaces, unless provided with a fusion-bonded epoxy coating shall be given a shop prime coating, with finish exterior coating applied in the field.

3.03 TESTS

- A. Shop and Laboratory Tests. Perform shop and laboratory tests on valves and appurtenances as follows:
 - 1. Wedge Gate Valves. Perform shop tests for leakage in accordance with AWWA C500, except no leakage shall occur with design pressure held for one minute.
 - 2. Butterfly Valves. The following applies to all sizes specified from 3-inch diameter to 84-inch diameter.
 - a. Material Tests. Physical and chemical properties tests shall be performed on all material components to be used in manufacture of butterfly valves in accordance with AWWA C504, including valve sleeve bearing materials.
 - b. Gear Operator Tests. Manufacturer shall test each model of gear operator and establish torque rating curves in accordance with AWWA C504.
 - c. Performance Tests. Manufacturer shall shop test each butterfly valve for performance, leakage, and hydrostatic pressure in accordance with AWWA C504. Manufacturer shall submit valve size, class, and results.
 - 3. Ball Valves. See 2.07 D.
- B. Field Tests. Test all valves and appurtenances for proper operating adjustments and settings and for freedom from vibration, binding, scraping, and other defects. The testing of the electrically controlled valves shall be supervised by a representative of the manufacturer who shall verify proper installation, adjustments, and performance. The adequacy of all pipe hangers and supports and valve supports to meet specified requirements shall be verified. All defects found shall be corrected.
- C. After installation all tapping sleeves and valves shall be field tested hydrostatically for two hours in the presence of the City Engineer. Test pressure shall be equal to that specified for the adjoining pipeline.

3.04 COORDINATION WITH INSTRUMENTATION.

- A. It shall be the responsibility of the Company to coordinate with Division 13 regarding the requirements of control valves.

3.05 COORDINATION WITH OTHER MECHANICAL SUPPLIERS

- A. The installation and operation of the valve and motorized or hydraulic actuators shall be the unit responsibility of the valve supplier.

3.06 CLEANING

- A. All valves and appurtenances shall be flushed clean of all foreign matter together with the piping as specified in other sections.

END OF SECTION

SECTION 15410 - PLUMBING FIXTURES**1.1 QUALITY ASSURANCE**

- A. Regulatory Requirement: **ICC A117.1**, 2007 Florida Building Code.
- B. Regulatory Requirement: Public Law 102-486.
- C. Quality Standard: NSF 61 for fixture materials in contact with potable water.
- D. Quality Standard for Electrical Components, Devices, and Accessories: NFPA 70, Article 100.

1.2 WARRANTY**1.3 FAUCETS - See plumbing fixtures cut sheets for the following:**

- A. Lavatory Faucets
- B. Shower Faucets
- C. Sink Faucets

1.4 FLUSHOMETERS See plumbing fixtures cut sheets for the following:

- A. Flushometers,

1.5 TOILET See plumbing fixtures cut sheets for the following:

- A. Toilet

- 1.6 WATER CLOSETS See plumbing fixtures cut sheets.
- 1.7 URINALS See plumbing fixtures cut sheets.
- 1.8 LAVATORIES See plumbing fixtures cut sheets.
- 1.9 COMMERCIAL SINKS See plumbing fixtures cut sheets.
- 1.10 INDIVIDUAL SHOWERS See plumbing fixtures cut sheets.
- 1.11 KITCHEN SINKS See plumbing fixtures cut sheets.
- 1.12 SERVICE SINKS See plumbing fixtures cut sheets.
- 2.0 SUBMITTALS
 - A. Submit shop drawings and material samples to Contract Administrator with copy to City Engineer for approval in accordance with Appendix 5 of the Service Contract.

END OF SECTION 15410

Features

- Vitreous china
- Wall-mount
- Single center hole
- With overflow
- ADA compliant
- Drilled for concealed arm carrier
- Optional soap dispenser hole on left (-L) or right (-R)
- 20" (50.8 cm) x 18" (45.7 cm)

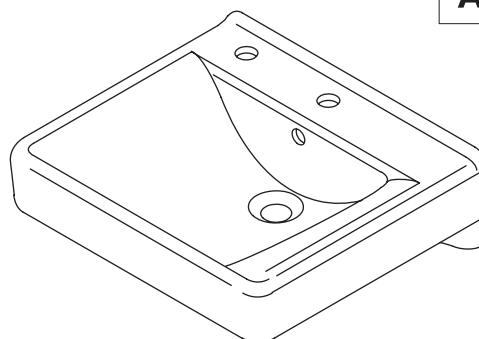
Codes/Standards Applicable

Specified model meets or exceeds the following:

- ASME A112.19.2
- ADA
- CABO/ANSI A117.1
- IAPMO/UPC
- CSA B45

WALL-MOUNT LAVATORY K-2084

ADA



Colors/Finishes

- 0: White
- Other: Refer to Price Book for additional colors/finishes

Accessories:

- CP: Polished Chrome
- Other: Refer to Price Book for additional colors/finishes

Specified Model

Model	Description	Colors/Finishes	
K-2084	Single-hole lavatory less soap dispenser hole	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2084-L	Single-hole lavatory with soap dispenser hole on left	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2084-R	Single-hole lavatory with soap dispenser hole on right	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2084-N	Single-hole lavatory less overflow	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2084-NL	Single-hole lavatory with soap dispenser hole on left less overflow	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2084-NR	Single-hole lavatory with soap dispenser hole on right less overflow	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
Recommended Accessories			
K-8998	Trap	<input type="checkbox"/> CP	<input type="checkbox"/> Other_____

Product Specification:

The wall-mount lavatory shall be 20" (50.8 cm) in length, and 18" (45.7 cm) in width. Lavatory shall be made of vitreous china. Lavatory shall have single-hole drilling. Lavatory shall have overflow. Lavatory shall be ADA compliant. Lavatory shall be drilled for concealed arm carrier. Lavatory shall have optional soap dispenser hole on left (-L) or right (-R). Lavatory shall be Kohler Model K-2084-_____.

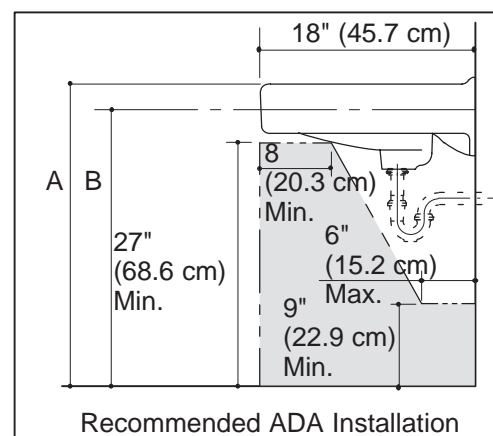
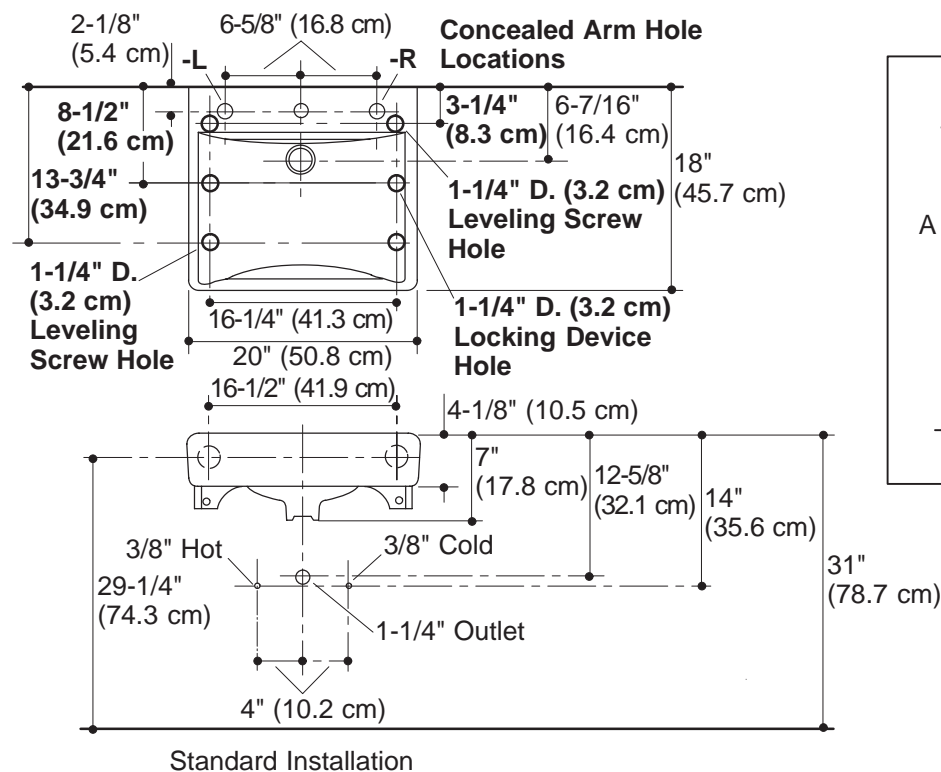
Technical Information

ADA compliant			
Fixture:*		basin area	water depth
Lavatory		18" (45.7 cm) x 13" (33 cm)	4-7/8" (12.4 cm)
Drain hole	1-3/4" D. (4.4 cm)		
* Approximate measurements for comparison only.			
Spout hole		Soap dispenser hole	
1-3/8" D. (3.5 cm)		1-1/4" D. (3.2 cm)	

Installation Notes

Install this product according to the installation guide.

A concealed arm carrier is required. It is **NOT** supplied by Kohler.



ADA rim height = A

34" (86.4 cm) Max.

32-1/2" (82.6 cm) Min.

ADA arm carrier height = B

32-1/4" (81.9 cm) Max.

30-3/4" (78.1 cm) Min.

Product Diagram



MODEL NUMBER:

■ **AC POWERED; single inlet**

- **6058.105** with cast spout, 0.5 GPM pressure compensating, vandal-resistant spray. Includes AC power supply.
- **6058.102** with cast spout, 1.5 GPM pressure compensating, vandal-resistant aerator. Includes AC power supply.

■ **OPTIONAL 4" or 8" Deck plates**

- **605P.400** 4" brass deck plate with 1/4" fixation studs and quick spin nuts. (6-1/8" x 2-1/8" x 1/2")
- **605P.800** 8" brass deck plate with 1/4" fixation studs and quick spin nuts. (10-1/8" x 2-3/8" x 1/2")

GENERAL DESCRIPTION:

Electronic faucet with proximity operation. Colored LED's signal temperature change mode. Vandal-resistant solid brass construction single post mounting. Operates on AC permanent power. Water pressure range from 20 to 125 psi. Dual inlets, built-in checks, and flexible stainless steel 20" reach inlet hoses for connection.

PRODUCT FEATURES:

Vandal-Resistant Brass Body: Durable - Excellent in high use applications.

Power Options:

- **Plug-In - Integral** low voltage transformer (115 VAC supply) with 6 foot long power supply.

Easy and Flexible Installation:

Single post mounting with optional 4" and 8" Deck plate. Water resistant solenoid enclosure mounts to wall.

Integrated; Easy Service Strainer:

Patented integrated strainer enclosed in removable debris cup protects the solenoid valve and aerator from debris. Perforated stainless steel strainer is low maintenance and can be easily accessed.

Temperature Mixing:

The water temperature gradually decreases/increases to a desired setting through a cyclic mixing valve. After usage, the faucet reverts back to a pre-setting temperature.

End Device:

Choice of 1.5 GPM (5.7 L/min) pressure compensating, vandal-resistant aerator or 0.5 GPM (1.9 L/min) pressure compensating, vandal-resistant spray.

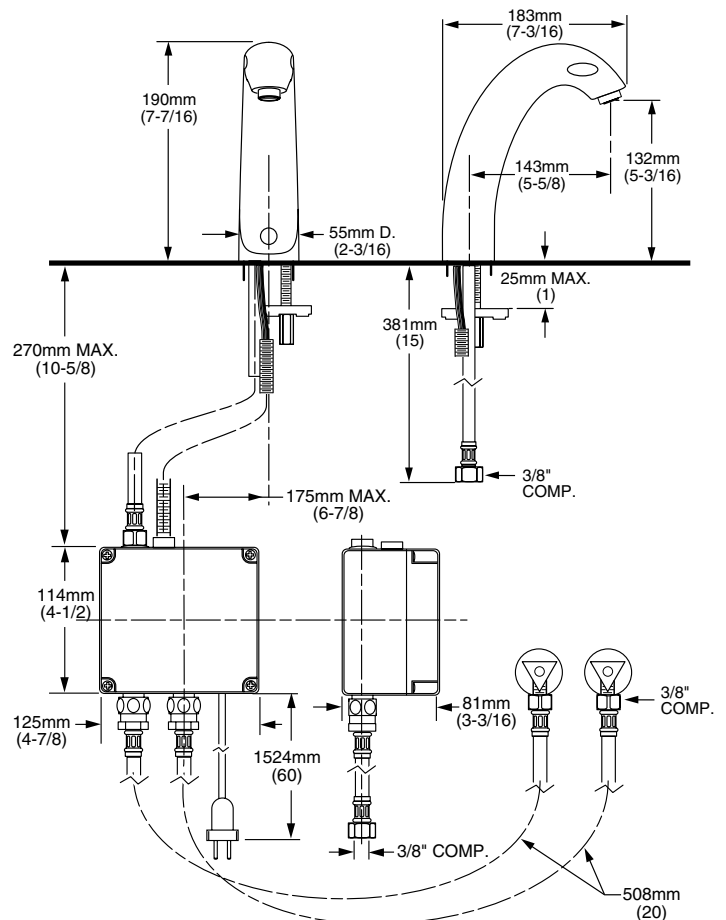
CODES AND STANDARDS:

These products meet or exceed the following codes & standards:

ANSI A117.1
ASME A112.18.1
CSA B 125



ADA Compliant



RECOMMENDED SPECIFICATION

Electronic Proximity Lavatory shall feature touch-free temperature control, vandal resistant all brass body with single inlet, built-in check valve, and in-line strainer. Shall also feature a low energy use electronically operated solenoid valve and microprocessor controlled proximity sensors. Shall meet ANSI A112.18.1M and ANSI 117.1 codes. Fitting shall be American Standard Model # 6058._____.

Hand Showers

Models B24, E24, HW

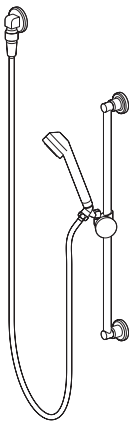
Features

- 60" flexible hose
- Chrome plated brass supply arm
- Vacuum breaker
- 2.5 GPM (9.5 L/min) flow control

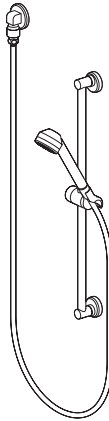
Standards

- All hand showers meet ANSI A112.18.1M flow requirements

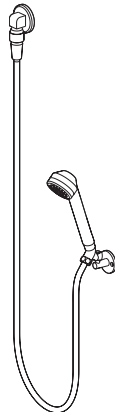
MODEL		
Model	Description	Part Number
<input checked="" type="checkbox"/> B24	24" Metal Slide Bar w/ Hand Shower	S30-091
<input type="checkbox"/> E24	24" Economy Slide Bar w/ Hand Shower	S30-092
<input type="checkbox"/> HW	Hand Shower w/ Wall Hook	S30-093



B24



E24



HW

Document No. 5520

This information is subject to change without formal notice.
© 2003 Bradley Corporation
3-24-2006 (2 Pages Total)

Bradley 

P.O. Box 309, Menomonee Falls, WI 53052-0309
Phone 1-800-BRADLEY FAX 262-251-5817
Web Site: <http://www.bradleycorp.com>

Hand Showers

Models SB, HS

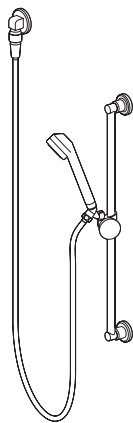
Features

- 60" flexible hose
- Chrome plated brass supply arm
- Vacuum breaker
- 2.5 GPM (9.5 L/min) flow control
- Quick Disconnect for Hose

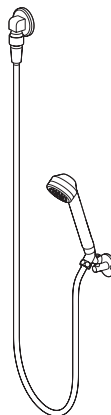
Standards

- All hand showers meet ANSI A112.18.1M flow requirements

MODEL		
Model	Description	Part Number
<input type="checkbox"/> SB	24" Metal Slide Bar w/ Hand Shower & Quick Disconnect	S30-035
<input type="checkbox"/> HS	Hand Shower w/ Wall Hook & Quick Disconnect	S30-067



SB



HS

AFWALL™ FloWise® ADA RETROFIT

- Wall-mounted flushometer valve toilet
- Vitreous china
- Meets definition for HET (High Efficiency Toilet)
- High Efficiency (4.8 Lpf/1.28 gpf)
- EverClean® surface inhibits the growth of stain- and odor-causing bacteria, mold, and mildew on the surface
- Elongated bowl
- Powerful direct-fed siphon jet action
- Fully-glazed 2-1/8" trapway
- 10" x 12" water surface area
- Condensation channel
- 1-1/2" inlet spud
- 100% factory flush tested

- ☐ **3355.128** Elongated bowl only, top spud
- ☐ **3356.128** Elongated bowl only, top spud with slotted rim for bedpan holding (White only)
- ☐ **3357.128** Elongated bowl only, back spud
- ☐ **3358.128** Elongated bowl only, back spud with slotted rim for bedpan holding (White only)

Afwall ADA 1.28 replaces standard wall-hung 3.5 or 1.6 models and roughs-in at 410mm (16-1/8") rim height **to meet ADA with no need to modify the existing carrier or through wall supply** (providing centerline of current outlet is 133mm [5-1/4"] above finished floor).

Component Parts:

- ☐ **047007-0070A** Inlet spud (furnished with bowl)
- ☐ **736046-100** Flushometer valve rough-in adapter kit (furnished with bowl)

Nominal Dimensions:

660 x 356 x 419mm
(26" x 14" x 16-1/2")

For Top spud bowls, American Standard kit #736046-100 Flushometer Valve Conversion Kit containing a 25mm (1") chrome-plated street ell, a vacuum breaker, and a 330mm (13") tail piece included to meet minimum 152mm (6") code between bowl and vacuum breaker.

Recommended working pressure—between 25 psi at valve when flushing and 80 psi static

Fixture only, less seat, carrier, bolt caps, and flushometer valve

Compliance Certifications -

Meets or Exceeds the Following Specifications:

- ASME A112.19.2 for Vitreous China Fixtures
- CAN/CSA International B45



SEE REVERSE FOR ROUGHING-IN DIMENSIONS

To Be Specified:

- ☐ Color: ☐ White ☐ Bone ☐ Silver ☐ Linen ☐ Black
- ☐ Seat:
 - ☐ American Standard #5901.100 Heavy duty open front less cover
 - ☐ American Standard #5905.100 Extra heavy duty open front less cover
- ☐ Flushometer Valve:
 - ☐ American Standard Selectronic™ #6065.121.002 DC Power (Top Spud)
 - ☐ American Standard Selectronic™ #6065.222.007 DC Power (Concealed Back Spud)
 - ☐ American Standard Selectronic™ #6067.222.007 AC Power (Concealed Back Spud)
 - ☐ American Standard Selectronic™ #6068.222.007 Multi AC Power (Concealed Back Spud)



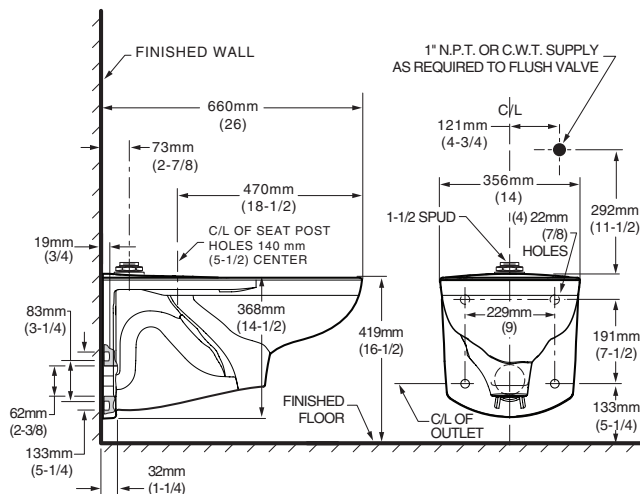
MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES AND ANSI A117.1 REQUIREMENTS FOR ACCESSIBLE AND USABLE BUILDING FACILITIES - CHECK LOCAL CODES.

- When installed so top of seat is 432 to 483mm (17" to 19") from the finished floor.

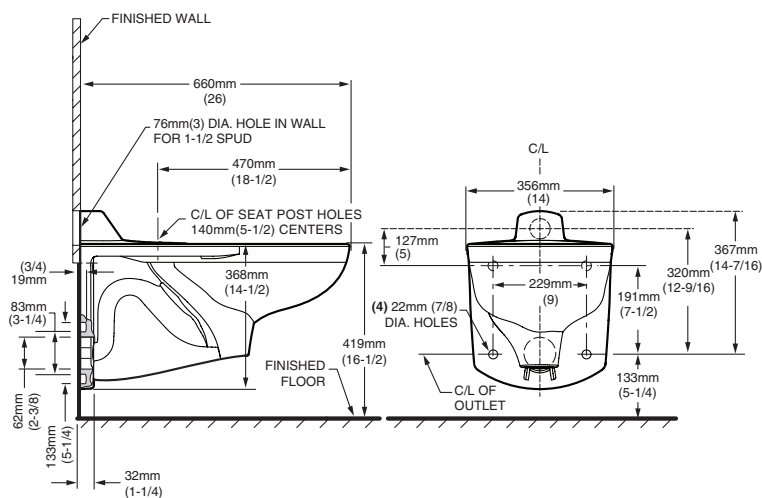


AFWALL™ FloWise® ADA RETROFIT 1.28 GPF FLUSHOMETER TOILET

3355.128/3356.128



3357.128/3358.128



NOTES:

● Toilet designed to meet ADA accessibility standards when top of seat height set at 432 to 483mm (17" to 19") from finished floor.

PRODUCT 3355.128 AND 3357.128 SHOWN, 3356.128 AND 3358.128 SAME AS EXCEPT WITH SLOTTED RIM FOR BED PAN HOLDING.

* REQUIRES AMERICAN STANDARD KIT 736046-100 TO UPGRADE EXISTING INSTALLATION OF FLUSHOMETER VALVE AND COMPONENTS. WASTE OUTLET SEAL RING MUST BE NEOPRENE OR GRAPHITE-FELT (WAX RING NOT RECOMMENDED).

SUGGESTED 1/16 CLEARANCE BETWEEN FACE OF WALL AND BACK OF BOWL. TO COMPLY WITH AREA CODE GOVERNING THE HEIGHT OF VACUUM BREAKER ON THE FLUSHOMETER VALVE, THE PLUMBER MUST VERIFY DIMENSIONS SHOWN FOR SUPPLY ROUGHING.

FLUSHOMETER VALVE NOT INCLUDED WITH FIXTURE AND MUST BE ORDERED SEPARATELY.

CARRIER FITTING AS REQUIRED TO BE FURNISHED BY OTHERS. PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS.

IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.

Features

- Vitreous china
- Undercounter
- With or without overflow
- Includes 52047 clamp assembly, unless specified
- 15" (38.1 cm) x 12" (30.5 cm)
- 17" (43.2 cm) x 14" (35.6 cm)
- 19" (48.3 cm) x 15" (38.1 cm)

UNDERCOUNTER LAVATORY

K-2209

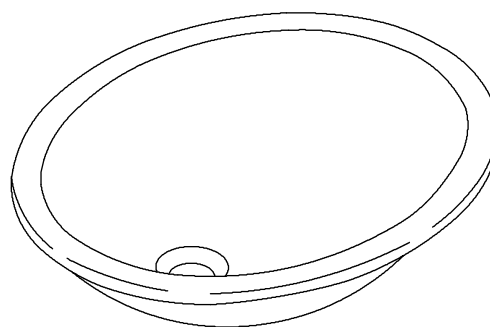
K-2210, K-2211

ADA

Codes/Standards Applicable

Specified model meets or exceeds the following:

- ADA
- ASME A112.19.2
- ICC/ANSI A117.1
- IAPMO/UPC
- CSA B45



Colors/Finishes

- 0: White
- Other: Refer to Price Book for additional colors/finishes

Accessories:

- CP: Polished Chrome
- Other: Refer to Price Book for additional colors/finishes

Specified Model

Model	Description	Colors/Finishes	
K-2209	Lavatory, 15" (38.1 cm) x 12" (30.5 cm), with overflow, with clamps	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2210	Lavatory, 17" (43.2 cm) x 14" (35.6 cm), with overflow, with clamps	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2210-G	Lavatory, 17" (43.2 cm) x 14" (35.6 cm), with glazed underside, without overflow, with clamps	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2210-L	Lavatory, 17" (43.2 cm) x 14" (35.6 cm), with overflow, without clamps	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2210-N	Lavatory, 17" (43.2 cm) x 14" (35.6 cm), without overflow, with clamps	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2211	Lavatory, 19" (48.3 cm) x 15" (38.1 cm), with overflow, with clamps	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2211-G	Lavatory, 19" (48.3 cm) x 15" (38.1 cm), with glazed underside, without overflow, with clamps	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____
K-2211-L	Lavatory, 19" (48.3 cm) x 15" (38.1 cm), with overflow, without clamps	<input type="checkbox"/> 0 White	<input type="checkbox"/> Other_____

Product Specification

The undercounter lavatory shall be 15" (38.1 cm) in length and 12" (30.5 cm) in width, 17" (43.2 cm) in length and 14" (35.6 cm) in width, or 19" (48.3 cm) in length and 15" (38.1 cm) in width. Lavatory shall be made of vitreous china. Lavatory shall be available with or without overflow. Lavatory shall include 52047 clamp assembly for all models except K-2210-L and K-2211-L. Lavatory shall be Kohler Model K-_____-_____.

Technical Information

Recommended Accessory			
K-8998	P-Trap	<input type="checkbox"/> CP	<input type="checkbox"/> Other_____

ADA compliant		
Fixture*:	Basin area	Water depth
K-2209	15" (38.1 cm) x 12" (30.5 cm)	4" (10.2 cm)
K-2210/ K-2210-L/ K-2210-N/ K-2210-G	17" (43.2 cm) x 14" (35.6 cm)	4" (10.2 cm)
K-2211/ K-2211-G/ K-2211-L	19" (48.3 cm) x 15" (38.1 cm)	4" (10.2 cm)
Drain hole	1-3/4" (4.4 cm) D.	
* Approximate measurements for comparison only.		

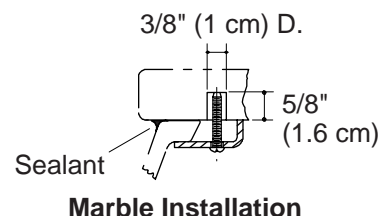
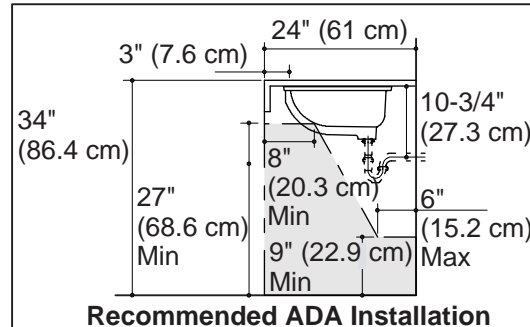
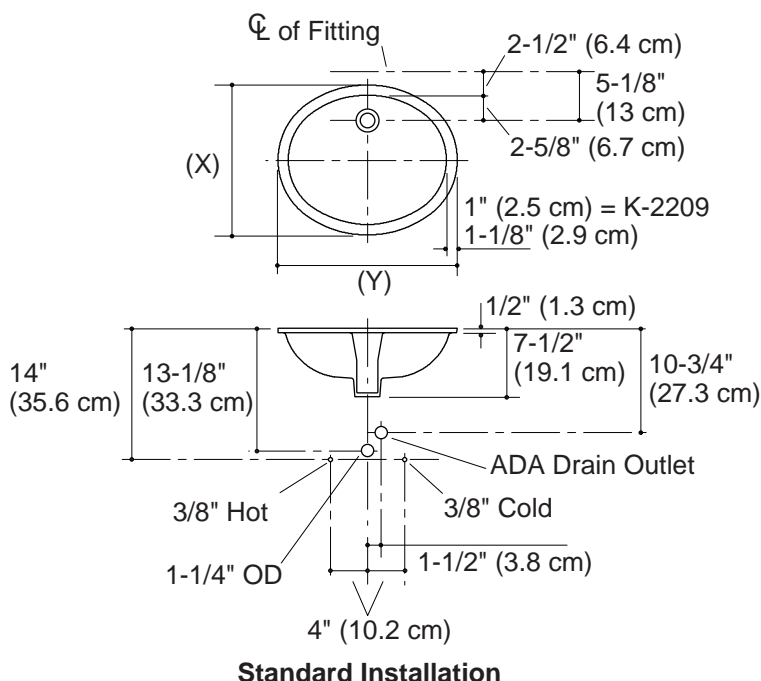
Included components:	
Basin clamp assembly (not included with K-2210-L and K-2211-L)	52047
Cut-out template, K-2209	85838-7
Cut-out template, K-2210	1002975-7
Cut-out template, K-2211	1018997-7

Installation Notes

Install this product according to the installation guide.

Supplied basin clamp assemblies require 1" (2.5 cm) minimum countertop thickness. Installer must supply anchors for thinner countertops.

K-2209: (X) = 14" (35.6 cm), (Y) = 17" (43.2 cm)
 K-2210: (X) = 16-1/4" (41.3 cm), (Y) = 19-1/4" (48.9 cm)
 K-2211: (X) = 17-1/4" (43.8 cm), (Y) = 21-1/4" (54 cm)



Product Diagram

WASHBROOK™ FloWise® 0.125 GPF ULTRA HIGH EFFICIENCY PINT URINAL SYSTEM

**WASHBROOK™ FloWise® 0.125 GPF
ULTRA HIGH EFFICIENCY PINT URINAL SYSTEM**

Design Matched Urinal & Flush Valve Provide Optimal Performance with Only 1 Pint of Water

-  **6590.525** 0.125 gpf Exposed Top Spud Urinal
with Selectronic™ Urinal Flush Valve

URINAL:

- Vitreous china
- Ultra High Efficiency (0.5 Lpf/0.125gpf)
- Flushing rim
- Elongated 14" rim from finished wall
- Washout flush action
- Extended sides for privacy
- Outlet connection threaded 2" inside (NPTF)
- 2 wall hangers and strainer included
- Meets ASME flush requirements at 0.125 gpf

SELECTRONIC FLUSH VALVE:

- Hygienic, touch-free operation
- Operates on DC Power (battery included)
- Self-Cleaning piston prevents clogging and greatly reduces maintenance
- Mechanical Override allows valve to be flushed during a power failure
- Fail Safe - valve automatically closes on loss of power; remains closed during restart
- Stadium Function reduces water consumption during periods of heavy usage
- Includes angle stop with vandal-resistant cap, sweat solder kit, vacuum breaker with adjustable tailpiece, spud coupling, and flange
- Chrome-plated brass body and metal cover

Nominal Dimensions:

355 x 470 x 1101mm
(14" x 18-1/2" x 43-3/8")

Recommended working pressure – between 20 psi at valve when flushing and 80 psi static

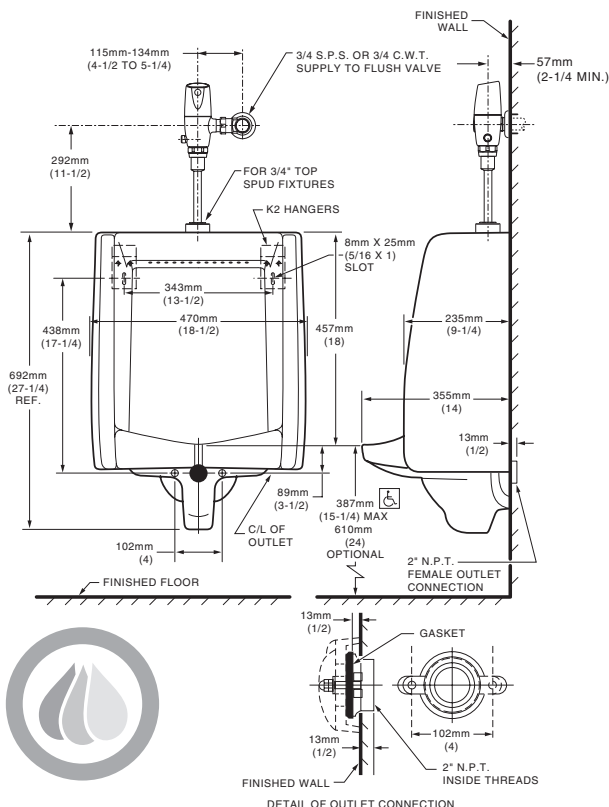
To Be Specified:

- ☐
- Color:
- ☐
- White
- ☐
- Bone
- ☐
- Silver
- ☐
- Linen
-
- ☐
- Black

Compliance Certifications -

Meets or Exceeds the Following Specifications:

- ANSI/ASME A112.19.2 & ASSE 1037



NOTES:

PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS.

IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.



**MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES
AND ANSI A117.1 ACCESSIBLE AND USABLE BUILDINGS AND
FACILITIES - CHECK LOCAL CODES.**

- When installed so top of rim is 387mm (15-1/4") from finished floor.

SECTION 15415 - DRINKING FOUNTAINS AND WATER COOLERS**1.1 SUMMARY**

- A. Drinking fountains.
- B. Pressure water coolers.
- C. Water-station water coolers.
- D. Remote water coolers.
- E. Fixture supports.

1.2 QUALITY ASSURANCE

- A. Regulatory Requirement: ICC A117.1, 2007 Florida Building Code.
- B. Quality Standard: NSF 61 for fixture materials in contact with potable water.
- C. Quality Standard for Water Coolers: ARI 1010, and ARI's "Directory of Certified Drinking Water Coolers" for style classifications.
- D. Quality Standard for Refrigerant: ASHRAE 34. HFC 134a (tetrafluoroethane), unless otherwise indicated.
- E. Quality Standard for Electrical Components, Devices, and Accessories: NFPA 70, Article 100.

1.3 DRINKING FOUNTAINS

- A. Drinking Fountains, Accessible, Style WS, wall mounting, semirecessed.
 - 1. Material: Stainless Steel
 - 2. Receptor Shape: Concave with projecting bowl.
 - 3. bubbler: One.
 - 4. Control: Push bar.
 - 5. Support: Mounting frame or brackets for attaching to substrate.

1.4 PRESSURE WATER COOLERS

- A. Water Coolers, Accessible, ARI 1010, Type PB, pressure with bubbler, Style WS, semirecessed side by side for adult and child mounting.
 - 1. Cabinet: All stainless steel.
 - 2. Bubbler: One.
 - 3. Control: Push bar.
 - 4. Filter: One or more water filters for cyst and lead reduction.

5. Cooling System: Electric.
 - a. Capacity: 12 gph (0.0126 L/s) cooled water.
 - b. Electrical Characteristics: [1/6] [1/5] hp; 120-V ac; single phase; 60 Hz.
6. Support: Mounting frame or brackets.

2.0 SUBMITTALS

- A. Submit shop drawings and material samples to Contract Administrator with copy to City Engineer for approval in accordance with Appendix 5 of the Service Contract.

END OF SECTION 15415

SECTION 15485 - ELECTRIC WATER HEATERS**1.1 SUMMARY**

- A. Instantaneous electric water heaters.

1.2 QUALITY ASSURANCE

- A. Quality Standard for Performance Efficiency: ASHRAE/IESNA 90.1 and ASHRAE 90.2.

1.3 WARRANTY

- A. Materials and Workmanship:
 - 1. Instantaneous Electric Water Heaters: Five (5) years.

1.4 PRODUCTS

- A. Flow-Control, Instantaneous Electric Water Heaters: Comply with UL 499 for tankless electric (water heater) heating appliance.
 - 1. Construction: CPVC piping or tubing complying with NSF 61, without storage capacity.
 - 2. Pressure Rating: 150 psig (1035 kPa) or as determined by Plumbing Engineer.
 - 3. Heating Element: Resistance heating system.
 - 4. Temperature Control: Flow-control fitting.
 - 5. Safety Control: High-temperature-limit cutoff device or system.
 - 6. Flow Rate: As determined by Plumbing Engineer.
- B. Water Heater Accessories:
 - 1. Combination temperature and pressure relief valves.
 - 2. Pressure relief valves.
 - 3. Water heater stand and drain pan units.
 - 4. Water heater stands.
 - 5. Water heater mounting brackets.
 - 6. Drain pans.
 - 7. Piping Manifold Kits: Manufacturer's factory-fabricated piping arrangement.
 - 8. Piping-Type Heat Traps: Field-fabricated piping.

1.5 SOURCE QUALITY CONTROL

- A. Water Heater Storage Tanks, Specified to Be ASME-Code Construction: Tested and inspected according to ASME Boiler and Pressure Vessel Code.

2.0 SUBMITTALS

- A. Submit shop drawings and material samples to Contract Administrator with copy to City Engineer for approval in accordance with Appendix 5 of the Service Contract.

END OF SECTION 15485

SECTION 15500

HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide and install all heating, ventilating and air conditioning (HVAC) equipment as indicated on the drawings and specified herein. Workmanship shall be best quality and in compliance with best practices.

1.02 REFERENCES

- A. Air Movement and Control Association, Inc. (AMCA) approved.
- B. Air Conditioning and Refrigeration Institute (ARI).
- C. Underwriters Laboratories (UL) approved.

1.03 SUBMITTALS

- A. Submittal data is required for all HVAC equipment specified herein. In addition to copies of standard manufacturers technical data, a separate itemized list shall indicate fan number, area served, model number, voltage and phase, cfm, static pressure and sound level in sones and complete power and control wiring diagrams. Operation and Maintenance manuals shall be submitted.

1.04 TESTING

- A. Test and balance of HVAC equipment shall verify approved submittal data and record nameplate data on all equipment.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Air conditioning and heating units, exhaust fans, ductwork and accessories shall be new and submitted in accordance with Appendix 5 of the Service Contract.

PART 3 - EXECUTION

3.01 INSTALLATION AND WORKMANSHIP

- A. A set of drawings and specifications, for use by mechanical trades only, shall be on the job site at all times. As-built notations shall be made on this set.
- B. Equipment shall be installed per the manufacturer's installation instructions.

- C. Installation shall provide for proper access for lubrication, cleaning, coil pull, filter service, balancing, etc.
- D. Workmanship shall be per commercial practice, at the interpretation of the City Engineer and defective workmanship shall be cause for repair or replacement.

3.02 SUPERVISION

- A. Supervision of all power wiring to mechanical equipment shall be provided by the Company. Furnish all necessary wiring diagrams.

3.03 CUT/PATCH, AND CLEANUP

- A. Cut/Patch, and Cleanup shall be coordinated with other trades to prevent interferences and to match adjacent work. Patching shall be with materials and methods as directed by the City Engineer. Damage to work of other trades shall be repaired by the Company at no additional expense to the City. The approval of the City Engineer shall be obtained before any structural member or waterproof membrane (roof, floor slab, etc.) is cut or penetrated. Clean-up job site prior to acceptance.

3.04 INSTRUCTION – NOT USED

3.05 INDEPENDENT TEST AND BALANCE

- A. An independent test and balance shall be provided with the services of an independent test and balance agency. The test and balance agency shall specialize in such type work, be a member of the AABC (Associated Air Balance Council) or of the NEBB (National Environmental Balancing Bureau). The forms used shall be based on recommendations of AABC or NEBB.

END OF SECTION

SECTION 16010

GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide electrical systems including existing system rework as indicated on the drawings and specified herein. Where the term "herein" is used, it includes Division 16 and all sections thereof.

C. Related Design-Build Work. Coordinate electrical work with the requirements of Division 13.

1.02 DEFINITIONS

A. Provide: As used herein shall mean "furnish, install, and connect complete".

B. Control and Interlock Wiring: All wiring, both line voltage and low voltage, other than power wiring.

C. Wiring: As used herein shall mean "wire or cable, installed in raceway with all required boxes, fittings, connectors, and accessories, completely installed".

D. Power Wiring: Wiring from the electrical distribution panel thru the primary control device to an item of equipment.

E. Concealed: Not visible. Such as items above ceilings, in attics, in crawl spaces, in chases, in tunnels, in walls, in cabinet work, under counters or equipment, and underfloor or underground.

F. Design-Build Work: As used herein shall be understood to mean the materials completely installed, including the labor involved.

G. Finished Spaces or Areas: All spaces except concealed spaces and mechanical, electrical or telephone rooms unless otherwise noted.

H. Noted, Shown or Indicated: Where these items are used, the words "in the specifications or on the drawings" shall be understood.

I. See Article 100 of the National Electrical Code for additional definitions.

1.03 SUBMITTALS

A. Parts List. A list of the major equipment shall be submitted for procurement in accordance with Division 1 requirements. The list shall include the item, the manufacturer and the manufacturer's part numbers along with a brochure on the part. The list shall include the following equipment categories (details specified in other sections) as a minimum:

1. Power Transformers
2. Low Voltage Switchgear
3. Motor Starters
4. Lighting fixtures
5. Local control panels
6. Variable frequency drives
7. Reduced Voltage Soft Starters
8. Panel Boards
9. Fire alarm Systems and Components
10. Access Control Systems and Components
11. Closed Circuit Television Systems
12. Conduit, cable and wire
13. Pullboxes, handholes and manholes
14. Wiring devices
15. Transient voltage surge suppression devices
16. Lightning Protection System

B. Electrical design drawings shall include, where applicable:

1. Interior light and power distribution
2. Fire alarm systems
3. Access Control Systems
4. CCTV Systems
5. Exterior electric power supply and distribution

6. Grounding and lightning protection systems, including fence grounding and special instructions issued by the client
7. Communication systems

C. Shop Drawings. Shop drawings shall be prepared per Appendix 5 of the Service Contract and shall be submitted for approval. These shall include as a minimum the following:

1. Detail duct bank, cable routing and manhole locations and details.
2. Schematics, in ladder diagram form, and wiring diagrams of all controls, including power circuit breakers. Schematics shall comply with NEMA and JIC Standards.
3. Above ground conduit and cable routing details.
4. Switchgear elevations and installation details.
5. Conduit Labeling.
6. All drawings and submittals shall be in English. Schematics and Interconnection drawings shall conform to NEMA and JIC standards.

D. As-Built Drawings. The Company shall maintain and submit a set of complete as-built drawings. These drawings shall be updated using CAD and provided as a final set. These shall include as a minimum:

1. Above and below grade electrical plans.
2. Schematics and wiring diagrams.
3. Switchgear elevations
4. Single line diagrams.
5. Power and lighting panel schedules.
6. Conduit and cable schedules.

E. UL Approval. Equipment shall be UL listed. If the item bears a UL label, no further documentation is required unless requested by the Consultant. If the item does not bear a UL label, the Company shall submit a copy of the UL listing card for approval prior to installation.

F. The City Engineer's review of submittals shall be considered general in nature and does not guarantee nor relieve the Company from responsibility for compliance with specifications or suitability to the project.

G. Submittals shall be submitted only for items as specified or prior approved. Any request for deviations from the drawings or specifications shall be made separately and clearly identified as a request for deviation.

1.04 CODES AND ORDINANCES

A. Where requirements of these specifications exceed specified codes and ordinances, conform to these specifications. Where code requirements exceed specified requirements, conform to code requirements. Where deviations from the drawings or specifications are required to comply with codes, the Company shall notify the City Engineer prior to making changes.

B. All Design-Build Work shall comply with the latest amended editions of the codes and standards listed below, and the codes and ordinances of the authority having jurisdiction. The Company is assumed to be familiar with all federal, state, and local laws, ordinances, rules and regulations that in any manner affect the Design-Build Work. Ignorance on the part of the Company will in no way relieve him from responsibility.

C. Codes and Standards. Provide electrical equipment and materials, including installation, conforming to the following codes and standards, as applicable. The equipment and materials shall bear labels to indicate manufacturing conformance to the specified standards or equal. Where two codes or standards are at variance, conform to the more restrictive requirement:

1. National Electrical Code
2. National Electrical Safety Code
3. County and City Electrical Codes
4. American National Standards Institute
5. Certified Ballast Manufacturers
6. Illuminating Engineering Society
7. Institute of Electrical and Electronic Engineers
8. Insulated Power Cable Engineers Association
9. National Electrical Manufacturers Association

10. National Fire Protection Association
11. Occupational Safety and Health Act
12. Public Utilities Service Requirements
13. Underwriters Laboratories, Inc.

1.05 ELECTRICAL DRAWINGS

A. The electrical installation as shown on the drawings is schematic in nature and shows approximate location and dimension of equipment. In most cases these are based upon preliminary data from a single manufacturer and standard catalog cuts. All dimensions shall be verified at the building site and are not to be scaled from the electrical drawings. If the Company determines that the equipment that he proposes cannot be located as shown, it shall be installed as close as possible to that shown at no additional cost. In the same context, if the electrical connections of the equipment he proposes to provide vary in detail from the diagrams shown on the Plan, the Company shall provide a complete installation at no additional cost. In either circumstance, the Company shall prepare and submit for approval, shop drawings based upon the actual equipment procured.

1.06 UTILITY INTERFACE

A. Power. The public utility providing electrical power service is Florida Power & Light (FP&L). The Company shall coordinate his Design-Build Work with the utility and shall comply with all rules, regulations, and requirements invoked by them, as well as requirements of these specifications and Division 1. Changes made by the utility shall be provided by the Company without additional charges to the City.

1.07 PERMITS AND INSPECTION

A. The Company shall obtain, and keep on file at the job-site, necessary permits and inspection certificates. Upon completion of the electrical work the Company shall present all such certificates to the County Administrator with copy to the City Engineer.

1.08 MANUFACTURER'S CERTIFICATES

A. Where required by these specifications, the Company shall furnish the County Administrator with copy to the City Engineer with the manufacturer's certificate, stating that the equipment item has been installed under either continuous or periodic supervision of the manufacturer's authorized technical representative, that settings and adjustments have been made properly and that the item is operating in accordance with the specified requirements and to the manufacturer's standard recommendations. As related to this requirement, the Company shall include in his contract price the total cost of providing the required on-site services of said technical representative. Items shall include as a minimum:

1. Switchgear

2. Power transformers
3. Variable speed drives
4. Motor Starters
5. Fire Alarm System
6. Access Control System
7. Filters
8. Transient voltage surge suppressers
9. Lightning Protection

1.09 COORDINATION

A The Company shall coordinate the work specified herein with work to be performed under other divisions of the specifications. Downtime of equipment and operating processes shall be kept to a minimum.

- B. The Company shall coordinate RTU & I/O conduit, wire runs, and location closely with the systems integrator and the electrical subcontractor. See Section 13322.

1.10 MANUALS

A. Complete sets of operating and maintenance manuals shall be prepared and submitted to the Contract Administrator with copy to City Engineer for approval. Upon completion of the electrical work, the Company shall deliver the number of sets as required by Appendix 11 of the Service Contract.

1.11 DISSIMILAR METALS

A. The use of dissimilar metals in direct contact shall not be permitted unless explicitly stated herein or shown on the drawings.

B. All electrical conductors (wire, cable, bus, terminal block points, etc.), shall be copper. Tin plating, silver plating and other treatment shall be provided as required and specified.

1.12 FINISH & PAINTING

A. The following are minimum requirements for the electrical installation:

1. Galvanizing. Zinc coating shall be applied to bright metal by processes and to thickness required by the applicable governing standard. Where zinc coating is marred or removed during the installation process (by welding, etc.), the surface shall be cleaned and coated with 2 coats of a cold galvanizing compound.

2. Cast Metals.

- a. Cast aluminum fittings and enclosures shall have a natural finish, unless noted otherwise.
- b. Cast ferrous metal fittings and enclosures shall have an electrostatically deposited zinc coating and a final coating of aluminum lacquer, such as Crouse-Hinds Feraloy or equal.

3. Stainless Steel. Stainless steel fittings and enclosures shall have a natural finish, unless otherwise noted. All hardware including but not limited to bolts, screws, used for mounting shall be 316 stainless steel.

4. Sheet Ferrous Metal.

- a. NEMA 1 - Painted items, shall be finished in accordance with the manufacturer's standard practice, but shall include as a minimum - 1 finish coat of acrylic enamel and 1 primer coat applied over a phosphatized surface.
- b. NEMA 12 - 2 coats of acrylic enamel and 2 primer coats applied over a phosphatized surface. An acceptable alternate is a coating of electrostatically deposited and treated polyester powder over a phosphatized surface.

5. Color. Unless noted otherwise, painted surfaces shall have colors as listed below, in accordance with ANSI-Z55.1.

- a. Lighting fixtures and other devices, unless otherwise indicated, shall be finished in accordance with manufacturer's standard practice.
- b. Optional panels and/or panel interiors for device mounting shall be white. Panel interiors and general enclosure interiors may be ANSI-61. Circuit breaker panelboard, motor starter enclosures, and similar enclosures may also have ANSI-61 interiors.

1.13 SURGE AND LIGHTNING PROTECTION

A. Panelboards, switchboards, chlorine analyzers, instrumentation devices, variable frequency drives, control panels (LCP's and UCP's) and other electrical devices shall be equipped with lightning and surge protection as specified in Section 16709.

1.14 TESTING / INSPECTIONS

A. The Company shall perform the tests as specified herein, including tests in applicable standards referenced in paragraph 1.02, hereinbefore, and as required to support driven-equipment tests as specified and required by Divisions 1 through 16. The Company shall maintain records of test results and deliver them to the Contract Administrator with copy to City Engineer upon completion of the electrical work.

B. The Company shall furnish written notice as to when equipment or systems requiring field testing will be tested so that the City Engineer may be present to witness the test. At least one

week's notice shall be given.

C. The Company shall notify the City Engineer of any required inspections which are scheduled with the authorities having jurisdiction so the City Engineer may be present. At least one week's notice shall be given.

D. At final inspection, a test shall be made and the entire system shall be shown to be in working condition. The following shall be made available to personnel conducting the test:

Electrician with hand tools

Voltmeter

Clamp on Ammeter

Phase Rotation Indicator

COMPLETE SPECIFICATIONS AND DRAWINGS WITH ALL ADDENDA
AND REVISIONS.

E. All Design-Build Work and materials found to be in non-compliance with the Design Documents shall be replaced and re-tested by the Company at no additional cost to the City.

1.15 SPARE PARTS

A. The Company shall provide spare parts specified herein and required by Division 1. In addition, he shall provide spares used or required for maintenance during the time period that the equipment is in his custody. He shall also provide required consumables during this period.

1.16 SHORT CIRCUIT ANALYSIS AND COORDINATION STUDIES.

A. Calculation of the maximum rms symmetrical three-phase short-circuit current at each significant location in the electrical system shall be made using a digital computer.

- B. Appropriate motor short-circuit contribution shall be included at appropriate locations in the system so that the computer calculate values represent the highest short-circuit current the equipment will be subjected to under fault conditions.
- C. A tabular computer print-out shall be included which lists the calculated short-circuit currents, X/R ratios, equipment short-circuit interruption or withstand current ratings, and notes regarding the adequacy or inadequacy of the equipment.
- D. The study shall include a computer print-out of input circuit data including conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedance and X/R ratios, motor contributions, and other circuit information related to the short-circuit calculations.
- E. Include a bus-to-bus computer print-out identifying the maximum available short-circuit current in rms symmetrical amperes and the X/R ratio of the fault current for each bus-to-bus calculation.
- F. The system one-line diagram shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.
- G. A comprehensive discussion section evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.
- H. The Company shall be responsible for supplying conductor information (lengths, types, number per phase, etc.) in a timely manner to allow the short-circuit analysis to be completed prior to final installation.
- I. Any inadequacies shall be called to the attention of the City Engineer and recommendations made for improvements as soon as they are identified.

PART 2 - PRODUCTS

2.01 EQUIPMENT, MATERIALS, AND METHODS

A. The Company shall provide equipment and materials and shall install items as shown on the Plans, as required by the specifications and as required to provide a complete installation.

PART 3 - EXECUTION

3.01 GENERAL

A. Design and install electrical work in accordance with the codes and standards specified, except where more stringent requirements are indicated or specified. Verify that materials and equipment properly fit the installation space with clearances conforming to the codes and standards specified except where greater clearance is indicated. Perform Design-Build Work as required to correct improper installations, at no additional cost to the City.

3.02 ELECTRICAL SUPERVISION

A. Assign a competent representative to supervise the electrical construction work from beginning to Final Completion.

3.03 INSPECTION

A. Inspect each item of material and equipment for damage, defects, completeness, and correct operation before installing. Inspect previously installed related work and verify that it is ready for installation of electrical work.

3.04 PREPARATION

A. Prior to installing electrical work, ensure that installation areas are clean. Maintain the areas in a broom-clean condition during installation operations. Clean, condition, and service equipment in accordance with the manufacturer's instructions, approved submittals, and other requirements indicated or specified.

3.05 WORKMANSHIP

A. Employ skilled craftsmen experienced in installation of the types of electrical materials and equipment specified. Use specialized installation tools and equipment as applicable. Produce acceptable installations free of defects.

3.06 FIELD QUALITY CONTROL

A. Manufacturers' Supervision and Field Installation Check. Where specified, electrical equipment manufacturer shall furnish the services of an authorized representative especially trained and experienced in the installation of his equipment to (1) supervise the equipment installation in accordance with the approved submittals and manufacturer's instructions, (2) be present when the equipment is first put into operation, (3) inspect, check, adjust as necessary, and approve the installation, (4) repeat the inspection, checking, and adjusting until all trouble or defects are

defects are corrected and the equipment installation and operation are acceptable, and (5) prepare and submit the specified Manufacturers' Certified Report.

B. Operational Demonstrations. Demonstrate that performance of installed electrical materials and equipment complies with requirements specified in Division 16. Operate equipment through entire no-load to full-load range for not less than 24 hours unless a longer period is specified elsewhere. Immediately correct defects and malfunctions with approved methods and materials in each case, and repeat the demonstration. Conform to the approved demonstration plan.

C. Final Operation Tests. Test all electrical systems for not less than 168 hours, with no interruptions except for normal maintenance or corrective work. Conform to the approved test plan. Coordinate with final operation tests required under Division 15.

1. Testing Materials. Furnish labor, instruments, recorders, gages, materials, and power for tests as required.

2. Testing Methods. Operate systems continuously 24 hours a day under constant inspection of trained operators. Cause variable speed equipment to cycle through the applicable speed range at a steady rate of change. Induce simulated alarm and distressed operating conditions, and test controls and protective devices for correct operation in adjusting system functions or causing system shutdown. Perform other final operation tests as may be required under other Sections of Division 16.

3. Defects. Immediately correct all defects and malfunctions disclosed by tests. Use new parts and materials as required and approved. Add the interruption time for corrective work to the specified total test period.

4. Test Records. Furnish approved instruments, gages, chart recorders, and other devices as required. Continuously record all function and operation parameters during entire test period. Submit data to the County Administrator with copy to City Engineer.

3.07 INSTRUCTION – NOT USED

3.08 CONSOLIDATION OF TESTING AND INSTRUCTION REQUIREMENTS.

A. Demonstration testing and final operation testing may be performed simultaneously, subject to prior approval of the extent of consolidation in each case.

B. Provide keys for all electrical equipment.

3.09 QUALITY CONTROL

A. The Company shall initiate and maintain a Quality Control Program as required by Appendix 4 of the Service Contract. He shall ensure monitoring and review of completed Design-Build Work by qualified inspectors, including the inspections required by the governing authorities. He shall notify the City Engineer, immediately upon discovery, of any discrepant item, and shall correct all such discrepancies forthwith.

END OF SECTION

SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section specifies materials, components, fittings, equipment and installation methods to be used in the Design-Build Work required by Division 16 and which are common to more than one Section thereof.

1.02 AREA CLASSIFICATION AND EQUIPMENT ENCLOSURES

A. Classification. Except where specifically indicated, the area is considered non-hazardous relative to article 500 of the N.E.C. The area, is however, damp and potentially corrosive. In addition, areas classified as hazardous in accordance with NFPA 820 "Fire Protection in Wastewater Treatment and Collection Facilities" shall comply with the requirements of a Class 1 hazardous location per N.E.C. Article 500.

1. The following areas shall be considered hazardous:

	<u>Location and Function</u>	<u>Class 1 Division</u>
A.	Above Grade Wastewater Pumping Stations	2
B.	Below Grade Wastewater Pumping Station	1
B.	Process Manholes	1
C.	Process Junction Chambers	1
D.	Catch Basins	2
E.	Below Grade Valve Vaults	2
F.	Below Grade Metering Vaults	2

B. Enclosures. The electrical installation shall contain enclosures to the following criteria, unless noted otherwise on the drawings or in the detail specifications:

1. Where the installation is outdoors or in the process areas, enclosures for electrical equipment shall be NEMA 4X, 316 stainless steel, unless otherwise noted. Outdoor enclosures shall include heat shields as required.

2. Where the installation is indoors, such as electrical and control rooms, enclosures shall be NEMA 1 or NEMA 12.

3. Enclosures in hazardous areas shall meet requirements for hazardous installation. Enclosures shall also be corrosion proof.

1.03 QUALITY ASSURANCE

- A. Electrical products shall be manufactured in the United States of America. Products which have been superseded by later models are not acceptable.

1.04 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Design-Build Work. Coordinate installing large equipment requiring positioning before closing in the building.

- C. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.

2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces.

E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

1.05 DELIVERY AND STORAGE

A. Products furnished under this Specification shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in strict accordance with the manufacturer's recommendations, and as approved by the City Engineer. Items damaged or defective in the opinion of the City Engineer shall be replaced at Company's cost.

1.07 MATERIALS AND WORKMANSHIP

A. All material shall be new, unused, and suitable for the service intended. Workmanship shall be of the highest quality, performed by skilled and experienced workers. Materials and equipment shall be catalogued, standard products of manufacturers regularly engaged in the production of such materials or equipment and shall be manufacturer's latest design that complies with the Specification requirements. Materials and equipment shall duplicate items that have been in satisfactory commercial or industrial use at least five (5) years prior to BID opening. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer. Each item of equipment shall have the manufacturer's name, address, model number, and serial number on the nameplate securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

PART 2 - PRODUCTS

2.01 CONDUITS AND FITTINGS

A. Conduit. Conduit which is surface mounted (exposed) and/or which is installed in classified hazardous locations per NEC shall be threaded, rigid, galvanized steel. Process areas (Chemical Room) exposed, shall be PVC, Schedule 80. No conduit shall have a nominal diameter of less than 3/4 inch trade size, unless noted otherwise. Conduit to be direct-buried below grade embedded in columns, walls or block walls shall be PVC, schedule 40, approved for direct burial, unless otherwise noted. Inside the electric rooms, EMT may be used. All unused conduit openings shall be plugged with a sealing compound, Dow Corning 3/6548 silicon RTU foam, or equal. Concrete floor penetrations shall be galvanized, rigid steel.

B. Standards. Conduit, conduit fittings and outlet bodies shall comply with the following standards:

1. Federal Specification WW-C-566.

C. Conduit Fittings:

1. Wall Entrance Seals: Entrance seals shall be provided where conduits pass through exterior concrete or masonry walls below grade. The entrance seals shall consist of a hot dip galvanized shell, sealing gland assembly capable of providing a seal around the conduit to withstand fifty foot head of water without leakage. The shell of the seal shall have at least two cast collars at a right angle to the sleeve that is embedded in the concrete. Entrance seals shall be O.Z./Gedney Type FSK, Spring City Type WEP, WDP, or equal.

2. Identification:

a. Exposed conduits and conduits concealed above removable ceilings shall be identified at junction and pull boxes and at points not more than 20 feet on centers with labels. Labels shall be adhesive backed vinyl, T&B type WDA, or equal.

b. Buried conduits shall be marked at each end of the run including hand holes, pull boxes and control panels. Marking shall be accomplished by means of an attached tag (cable or band).

c. Labels shall indicate the conduit number per the conduit schedule and the system voltage or type of service selected from the following list:

<u>System</u>	<u>Inscription</u>
Medium/High Voltage Circuits	HIGH VOLTAGE - POWER
480 Volt Circuits	480 VOLTS - POWER
480Y/277 Volt Circuits	480Y/277 VOLTS- POWER/LIGHTING
208/120 Volt Circuits	208/120 VOLTS - POWER
120 Volt Circuits (control)	120 VOLTS - CONTROL
Instrumentation Circuits	INSTRUMENT

d. Legend shall appear in black letters of 1/2 inch minimum height on a contrasting background. Labels shall be installed in accordance with the manufacturer's instructions and OSHA requirements.

2.02 WIRE AND CABLE

A. General. Sizes of wire and cable are American Wire Gage (AWG).

1. Insulated wire and cable shall be 98 percent conductivity, class B stranded, in accordance with ASTM Designation B8. The soft drawn bare copper (SDBC) shall meet ASTM Designation B3.

2. All wires shall have Class B stranding per ASTM B3 and no wire smaller than No. 12 AWG shall be used for power circuits unless noted otherwise. All wire and cable as shown on the drawings and specified herein shall be in (at a minimum a $\frac{3}{4}$ inch) conduit whether indicated or not unless specifically noted otherwise. No wire smaller than No. 12 AWG shall be used for power circuits unless noted otherwise. Minimum separation shall be maintained between runs of power, control and instrument cabling.

B. Power and Equipment Wiring.

1. Single conductors for power wiring shall be copper, stranded, type THHN/THWN, 90°C rated for 600 volts, or as otherwise indicated.

2. Equipment Wiring: Interconnecting wire and cable used in motor control centers, control panels, controllers, etc., shall be type SIS, 41 strand and conform to ANSI Standard for SIS Insulated Wires and Cables, Publication C8.36 and ICEA S-28-357. Wiring subject to repetitive movement shall be "extra flexible hinge wire."

3. Conductors buried in the earth for grounding requirements shall be soft drawn bare copper and shall meet ASTM designation B3.

4. Fixture wires shall be rated 600 volts, copper, 90°C thermoplastic insulated with an outer jacket type TFFN.

5. Manufacturer: Wire shall be manufactured by General Cable Company, Service Wire Company, or equal.

C. Control and Instrumentation Wiring. This class of wiring shall comply with the following standards - UL, subject 83, UL, subject 1277, ASTM D-2863, ASTM D-746, ASTM B-3, IEEE-383, ICEA S-61-402. Wires and cable sizes and types shall be as required by the DRAWINGS or specified herein or in Division 13.

1. Control Wire. Control wire shall be type TFFN, single-conductor, #14 AWG as indicated, unless otherwise noted.

2. Analog Signal Wire (Instrumentation). Instrumentation wire shall be Type TC, No. 16 AWG for single pair, triad, quad, multipair, multitriad or multiquad cables, all units individually shielded.

a. Insulation - 600 V, Flame retardant ethylene propylene, 90°C.

- b. Conductor - Copper, stranded.
 - c. Cable Jacket - Chlorinated polyethylene, flame resistant meeting requirements of IEEE-383 and UL1277 flame tests.
 - d. Shielding - Aluminum/mylar, 0.85 mil for single pair; and with 0.85 mil individual shield and individual jacket, 2.35 mils overall shield.
 - e. Drain Wire - #20 AWG stranded, tinned copper.
 - f. Color Code - per ICEA, S-61-402.
 - g. Ripcord for shield/jacket stripback.
 - h. Communication wire and overall shield/drain wire for multi-unit cable.
3. Acceptable manufacturers of control wire and cable furnished under items 1 and 2 (above) are: Okonite, Dekoron, Belden, or equal.

D. Wire Lubricant. Wire lubricant shall be used to ease the tension when pulling cable in conduit or ducts. The lubricant shall be Burndy-Slikon or Ideal-Yellow, or equal.

E. Splices and Connections.

1. No splices or joints shall be made in either feeders or branch circuits except at outlets, accessible junction boxes, or accessible raceways. Conductors No. 10 AWG or smaller shall be joined with splice caps applied with proper indenter tool, which provides deformation of the cap in 2 directions at right angles to each other simultaneously. For lighting and receptacle wiring in office areas, connections may be made by means of spring pressure connectors consisting of a cone-shaped expandable steel coil spring (wire nuts). Conductors larger than No. 10 AWG shall be joined by compression-type splicing sleeves utilizing appropriate dies and compression tool. Split bolt type connectors are not acceptable. Unless properly insulated by the connector, joints shall be insulated at least equal to the insulation of the conductors either with tape (Scotch 33) and linerless splicing tape or with heat shrink tubing or boots-T&B or Raychem.

2. Control Wiring Terminations. Control wire shall be terminated on terminal blocks where it enters the equipment, switchgear, control panels, leaves buildings or enters terminal boxes. The terminal blocks shall be 600V, rail mounted, Weidmuller type SAK 2.5 unless noted otherwise. Twenty percent spare terminals shall be included. Snap-in preprinted wire numbers shall be used to identify each terminal. Splices are not allowed.

G. Color Coding. Color coding shall be provided throughout the entire network of power feeder and branch circuits, as tabulated below:

PHASE	COLOR	
	208Y/120V	480Y/277V
A	Black	Brown

B		Red	Orange
C		Blue	Yellow
Neutral		White	White
Equip.	Ground	Green	Green
(if separate)			

H. Wire and cable for feeders and branch circuit distribution shall have the phase wires identified by factory color coding as indicated above, or by applying colored plastic tape to each conductor at splice points and terminations, Scotch #35 tape.

2.03 BOXES AND CABINETS

A. General. The Company shall provide boxes as shown on the drawings and specified herein. Cast metal outlet boxes shall be marine grade. Stamped steel boxes shall conform to Federal Specification No. W-O-8219. All NEMA 4X boxes shall be supplied with 316 stainless steel screws.

B. Types. Boxes for concealed work in office areas, unless otherwise indicated, or required, shall be standard 4 inch, square or octagon, and 2 3/4 inches minimum deep. Switch and receptacle boxes concealed in unplastered masonry walls, where a uniform finish is required, may be of the sectional type. Boxes and conduit fittings for surface-mounted work in process areas or weatherproof installation shall be marine grade. Boxes and conduit fittings in classified hazardous locations shall be explosion-proof per NEC 500.

C. Size and Manufacturer. All boxes shall be sized in accordance with the National Electrical Code except that conductor fill shall be limited to 80 percent of code allowance. Boxes shall be manufactured by Steel City, Hubbell, National, Crouse-Hinds or Appleton, or equal.

D. Covers and Identification. All boxes used for outlet, junction boxes or for equipment shall be furnished with appropriate covers and identification.

E. Moist Conditions. Exterior boxes and/or boxes exposed to moisture shall be NEMA 4X, marine grade construction. Boxes shall have external mounting feet, welded seams, neoprene gasket cemented in place and internal mounting panels when terminal strips are mounted in boxes. Galvanized boxes shall be provided with galvanized conduit. Drain fittings, Crouse Hinds, Type ECD 15, Killark No. KDB-1, or equal shall be provided in the conduit system where vertical runs exist, either in the box or in an adjoining outlet body.

F. All boxes, devices exposed to weather will have weatherproof covers at a minimum.

2.04 SUPPORTING DEVICES

A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.

B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.

C. Slotted-Steel Channel Supports:

1. Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.
2. Channel Thickness: Selected to suit structural loading.
3. Fittings and Accessories: Products of the same manufacturer as channel supports.

E. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- (14-mm-) diameter holes at a maximum of 8 inches (203 mm) o.c., in at least one surface.

1. Fittings and Accessories: Products of the same manufacturer as channels and angles.
2. Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.

G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.

H. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.

I. Expansion Anchors: Carbon-steel wedge or sleeve type.

J. Toggle Bolts: All-steel springhead type.

2.05 CONTROL STATIONS

A. Control stations such as selector switches, start/stop, pushbuttons, etc. located outdoors, in process areas and in all control panels shall be corrosion resistant, NEMA Type 4X, stainless steel and shall be Square D Class 9001, Type SK, Crouse-Hinds Type NCS or equal.

2.06 WIRING DEVICES

A. Device Plates. Device plates for use in dry locations shall be 0.060 inches stainless steel with brushed finish.

B. Switches. All switches shall be line voltage, specification grade, heavy duty, AC rated, 20 amperes, 120/277 volts, quiet type. The following catalog numbers of Arrow-Hart are specified for identification only. Switches shall be Arrow-Hart, or equal.

Device	Catalog Number
Single Pole Switch	1991
Three-Way Switch	1993

C. Receptacles.

1. Utility. General utility receptacles in office areas shall be flush, duplex grounding type, rated for 20 amperes at 125 volts. Receptacles shall be Arrow-Hart, No. 5452, or equal. Receptacles in all process areas shall have integral ground fault protection per the NEC.

2. Weatherproof Devices. Where devices are indicated on the drawings and/or in the specifications as being weatherproof, they shall be furnished complete with appropriate gasketed, "in use" weatherproof device plates fitted to weatherproof boxes or conduits, NEMA 4X. Screws and metallic hardware shall be 316 stainless steel.

3. Ground Fault Receptacles. Utility receptacles installed in process areas, outdoors, and as otherwise required by the NEC shall have ground-fault with indication features and shall be installed in a suitable outdoor "in use" weatherproof enclosure. The receptacle shall be rated for 20 amperes at 125 volts. The ground-fault receptacle shall be Bryant-GFR83 FT installed in NEMA 4 box with Bryant #RB57520 cover, or equal.

4. Receptacle patterns shall be as follows:

a. 120V - NEMA 5-20R

D. Safety Switches.

1. General: All safety switches shall be Type "H", heavy duty, horsepower rated, industrial type, with enclosures as shown on the DRAWINGS.

2. Manufacturer: Safety switches shall be manufactured by Eaton/Cutler-Hammer, General Electric, or Square D, or equal.

2.07 PANELBOARDS

A. General. Provide complete fully rated panelboards, as specified herein, as shown on the panelboard schedules, and on the DRAWINGS. Panelboards shall contain phase bus bars, insulated neutral bar, main, and branch circuit breakers. Circuit breaker type panelboards shall conform to Federal Specifications W-P-115a and circuit breakers shall comply with Federal Standard W-C-375b.

B. Circuit Breakers. Panelboards and circuit breakers shall be fully rated. Panelboards shall be of the dead front type, and shall have the frame, trip and interrupting characteristics indicated on the panelboard schedules. Panelboards shall be arranged as indicated on the panel schedules and as specified herein. All circuit breakers shall be of the bolt-on or plug-in, molded case type with both thermal and magnetic trip elements with ambient temperature compensation. Trip elements shall be of the interchangeable type, where so indicated. Main breakers shall be centered at top as shown on the drawings.

C. Construction.

1. Bus and Circuit Breakers. Panelboards shall be of the phase-sequence type construction. Busses shall be copper. Circuit breakers shall be bolted to the bus. Circuit breaker trip elements shall be sized to accommodate HID lighting fixture loads.

2. Enclosures. Panelboards shall have NEMA 12 enclosures. Panelboards located in office areas may be NEMA 1. All items should be finished ANSI-61 color. Panelboards located outside shall be NEMA 3R,

NEMA 3R, stainless steel, unless noted otherwise in corrosive or hazardous areas.

3. Classification and Rating. Panelboards shall be fully rated as shown on the drawings and specified herein. Classification shall be:

Panelboard Type	Characteristics
120/240 volts	Single phase, 3 wire, 60 Hz loads; 14,000 amperes IC, symmetrical
208Y/120 volts	Three phase, 4 wire, 60 Hz loads; 14,000 amperes IC, symmetrical
480Y/277 volts	Three phase, 4 wire, 60 Hz loads; 35,000 amperes IC, symmetrical

4. Lugs and Terminals. Mechanical type connectors shall be provided integral with main and branch circuit breakers. They shall be capable of connection to copper wire and cable conductors without use of an adapter. Main connections shall be double lugged. Panelboards shall be provided with an isolated neutral bus and with a ground bus solidly affixed to the case interior.

5. Finish shall be as specified for enclosures in Section 16010 Paragraph 1.12 Finish & Painting.

6. Panelboards shall be manufactured by Eaton/Cutler-Hammer, Siemens, Square D, or equal.

7. Panelboards shall be rated for harmonic loads.

8. Panelboards located in a separate building from the service shall be grounded in accordance with NEC Article 250-24.

D. Manufacturer. Panelboards shall be manufactured by either Cutler-Hammer, Square D, or General Electric. Substitution of other manufacturer's products are subject to approval by the City Engineer. Panelboards shall be current production models, and the manufacturer shall include written guaranteed product support for the next 5 years with the product submittals.

2.08 GROUNDING

A. Provide equipment and materials to ground the building as shown on the drawings. Ground rods shall be copper-clad steel, 3/4 inch diameter by a minimum of 10 feet long with pointed ends and chamfered tops. Each ground shall have 5 ohms resistance (maximum) when measured by a ground megger. If this is not achieved, drive additional rods and connect with (SDBC) as indicated. Connect ground rods to building steel with SDBC, size as indicated, and exothermic welds. Connect ground cables to ground rods with exothermic welds when buried, otherwise copper compression type ground rod to cable connector, Burndy

cable connector, Burndy Type YGLR or equal. Equipment will be grounded by an NEC compliant ground which shall run with the power circuit. Low voltage switchgear ground busses shall be tied directly to ground by at least two ground conductors per bus. Ground rods shall be Hubbard, Chance, Copperweld, or equal. All connections shall be coated with Dow-Corning 3145 RTV. Grounds shall be to a single point.

See Section 16450 for more details.

2.09 CONTROL RELAYS

A. Control relays shall be of the dust cover enclosed, plug-in type with 8 or 11 pin, screw terminal, octal sockets. They shall be rated for 10 amps at 120 VAC and be equipped with neon indicator lamps. Control relays shall be Potter-Brumfield or equal.

2.10 SURGE PROTECTION

A. See Sections 16670 and 16709.

2.11 ELECTRICAL IDENTIFICATION

A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.

B. Raceway and Cable Labels: Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and minimum length of color field for each raceway and cable size.

1. Type: Pretensioned, wraparound plastic sleeves. Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the item it identifies.

2. Type: Preprinted, flexible, self-adhesive, vinyl. Legend is overlaminated with a clear, weather- and chemical-resistant coating.

3. Color: Black letters on orange background.

4. Legend: Indicates voltage.

C. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick (25 mm wide by 0.08 mm thick).

D. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:

1. Not less than 6 inches wide by 4 mils thick (150 mm wide by 0.102 mm thick).

2. Compounded for permanent direct-burial service.

3. Embedded continuous metallic strip or core.

4. Printed legend that indicates type of underground line.

E. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

F. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.

G. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch (1.6-mm) minimum thickness for signs up to 20 sq. in. (129 sq. cm) and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in black letters on white background.

H. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.

I. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm), galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4-inch (6-mm) grommets in corners for mounting.

J. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.01 GENERAL

A. The Company shall supply, install, test, calibrate, start-up and operate the electrical systems as shown on the drawings as required by these Specifications, and in accordance with the NEC, the NESC, and with OSHA.

B. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

C. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

F. Future Growth: The Company shall provide for future growth by providing an additional 25% reserve space and capacity in above ground conduit and raceway supports.

3.02 PRE-SHIPMENT TESTING

A. Prior to shipment, the direct burial telemetry cable shall be tested in the factory to assure conformance with these specifications. The Company shall furnish a report that such testing has been conducted prior to shipment.

3.03 DELIVERY

A. The Company shall furnish and deliver the direct burial telemetry cable to the project site.

B. The Company shall deliver the direct burial telemetry cable, complete, within 8 weeks of shop drawing approval.

3.04 ABOVEGROUND INSTALLATION

A. The Company shall install the aboveground installation as shown on the drawings, locate the conduit banks and verify noninterference with equipment and piping. The conduit supports shall be designed and checked for structural integrity. Conduit racks may be fabricated from angle iron utilizing malleable iron clamps with clamp backs or strut type channel systems and galvanized steel clamps. Where strut type, full-thread hanger rod is used, it shall be 1/2" diameter (minimum). Where angle iron is used outdoors, or in process areas, or in manholes for electrical support, it shall be galvanized. Galvanized surfaces shall be coated with two coats of a cold galvanizing compound after welding - LPS-1G or equal. In corrosive and damp areas the bolts, nuts, and washers shall be stainless steel, and structure supports shall be coated after installation per Section 09905.

B. Where conduit is routed on walls, or smooth concrete or masonry surfaces, the conduit shall be installed at least 1/4 inch from the surface by use of plastic clamp backs. Conduit shall be run parallel or at right angles to structural beams, purlins or columns. Expansion shields and bolts shall be provided for support, as required. Conduit installed in concrete shall be so arranged so that spacing between conduits shall be sufficient to permit filling with concrete or mortar without voids. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors. Wherever practical, conduits and boxes for duplex receptacles and light switches shall be recessed in the wall.

C. Install raceways and cables at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Locate horizontal raceway runs above water and steam piping.

D. Make conduit bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

E. Use raceway and cable fittings compatible with raceways and cables and suitable for use and location.

F. Anchor bolts, U-bolts, expansion shields and bolts, and toggle bolts, including insert washer and nut, shall be stainless steel.

G. As each run of conduit is completed, temporary seals shall be used to plug conduits to prevent accumulation of mortar, dirt, or foreign objects in the run. All conduits shall be cleaned by pulling a mandrel through them before pulling wire or cable.

H. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of the pull wire.

I. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72-inch (1830-mm) flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.

J. Steel supports shall be painted as specified hereinbefore and in Division 9. Conduits in conduit banks shall be identified utilizing the conduit schedule numbers on all-temperature adhesive-backed vinyl tape. Letters shall be a minimum 1/2-inch high.

K. Pullboxes or pulling type outlet bodies shall be provided and installed by the Company to facilitate pulling wire and cable as required by his proposed routing.

L. Electrical equipment such as lighting panels, transformers, junction boxes, and control panels shall be installed prior to connecting the conduit. Equipment such as motors and field-mounted instruments shall be connected with liquid tight flexible conduit with internal grounding conductor.

M. The lighting fixtures shall be turned on and the lighting levels verified.

N. Where installation procedures are required to be in accordance with the recommendations of the manufacturer of the material or equipment being installed, printed copies of these recommendations shall be furnished to the Contract Administrator with copy to City Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

3.05 INSTALLATION OF WIRE AND CABLE

A. Install splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

B. Install wiring at outlets with at least 12 inches (300 mm) of slack conductor at each outlet.

C. Connect outlet and component connections to wiring systems and to ground. Tighten electrical connectors and terminals, according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.

D. The wiring shall be installed and the insulation shall be tested and recorded. The power, lighting and control wire insulation shall be meggered (1) prior to connection to equipment, and (2) prior to initial energization of the equipment. Splices and terminal lug sleeves, unless preinsulated shall be insulated with a sealing type heat-shrink sleeve - T & B, Raychem, or equal. Where voids must be filled to provide a smooth connection, use sufficient layers of Scotch #33 tape prior to applying the heat-shrink sleeve.

E. Conductor insulation resistance shall have minimum values as follows:

1. No. 12 AWG or smaller - 1,000,000 ohms
2. No. 10 AWG to No. 1 AWG - 1,500,000 ohms
3. No. 1/0 AWG or larger - 2,000,000 ohms

Motors shall be measured prior to connection and shall be greater than 5,000,000 ohms. A 500 volt megger shall be used for motors and 120/208 volt circuits. A 1,000 volt megger shall be used for 480 volt circuits.

E. Pullboxes. Pullboxes or pulling type outlet bodies shall be provided where required to facilitate pulling wire and cable. A pulling compound shall be used as specified hereinbefore.

F. Wire Identification.

1. Wire markers shall be provided to identify each conductor at equipment terminals, and in intermediate terminal boxes.

2. At motor terminals, at control stations, and in terminal boxes, identify each circuit conductor with the wire number. At panelboards and junction boxes, identify each panelboard circuit conductor with the panelboard number and circuit number. The individual conductor wire markers shall be non-adhesive hotstamped PVC sleeve as manufactured by Brady, Thomas & Betts, or equal or embossed clip sleeve type as manufactured by Brady, or equal. The wire marker to identify groups of conductors shall be nylon cable tie markers as manufactured by Thomas & Betts or Panduit. The marker pads on the cable tie markers shall be large enough to show the motor numbers. The motor numbers on the cable tie marker shall be 3/16-inch high minimum and shall be applied to the marker pads by marking pens which shall be provided by the

by the manufacturer of the cable tie markers.

3. Other control and instrumentation wiring shall be identified at panels and junction boxes with numbers shown on the drawings. If there is no number on the drawings, the Company shall assign a number. This number shall appear on submitted shop drawings and as-built drawings. The individual conductor wire markers shall be non-adhesive hot-stamped PVC sleeve as manufactured by Brady or Thomas & Betts or embossed clip sleeve type as manufactured by Brady.

4. On panelboards, a directory holder with transparent coverplate and metal frame shall be mounted on the inside cover of each panelboard with a neatly typed circuit directory properly identifying each circuit. An engraved nameplate of Micarta, or equal, with white cut letters on a black field shall also be provided on the inside cover, centered above the circuit directory. Nameplate shall bear panelboard designation and system characteristics.

G. Conductors shall be sized to limit voltage drop to not more than 3%.

H. To prevent problems with induced voltages on signal wires, the Company shall establish guidelines for separation of conductors of different voltage levels and signal types. These guidelines shall identify minimum separation of power and signal wires running in parallel raceways and cable trays. Submit guidelines for information.

3.06 EQUIPMENT IDENTIFICATION

A. The Company shall install laminated phenolic name tags on each piece of electrical equipment specified herein or shown on the drawings. The name tags shall be black-white-black and engraved to yield white letters and white beveled trim on a black background. The size of the name tags, size of letters shall be the manufacturer's standard size. The Company shall prepare a consolidated list of the name tags and submit to the Contract Administrator with copy to City Engineer for approval prior to engraving. The name tags shall be fixed to the equipment with 316 stainless steel screws or permanent epoxy cement. The list shall include the names of items controlled by each of the following:

1. Low voltage power circuit breakers.
2. Disconnect switches, controls, indicators and auxiliary devices.
3. Starters, variable frequency drive starters, circuit breakers, and auxiliary devices.
4. Local push button controls, selector switches, disconnect switches, control panels, pilot devices and motor tag number.
5. 480-240/120 volt transformers and power and lighting panelboards - all voltages.
6. Major junction boxes and all terminal boxes.

3.07 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb (90-kg) design load.

3.08 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.
- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.
- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls

and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
6. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply with AWS D1.1.
7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.09 PENETRATIONS OF STRUCTURE

A. If the electrical installation penetrates any wall, floor or other structural partition, the opening shall be sealed to the same degree of security required for the original partition. If the partitions are fire-rated, the penetration shall be with approved fire-stop methods and materials.

3.10 CONCRETE BASES

A. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 3.

3.11 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Raceways.
2. Building wire and connectors.
3. Supporting devices for electrical components.
4. Electrical identification.
5. Electricity-metering components.
6. Concrete bases.
7. Electrical demolition.
8. Cutting and patching for electrical construction.
9. Touchup painting.

B. Test City's electricity-metering installation for proper operation, accuracy, and usability of output data.

1. Connect a load of known kW rating, 1.5 kW minimum, to a circuit supplied by the metered feeder.
2. Turn off circuits supplied by the metered feeder and secure them in the "off" condition.
3. Run the test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use a test load placement and setting that ensure continuous, safe operation.

4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at the test load connection. Record test results.
5. Repair or replace malfunctioning metering equipment or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

3.12 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9.

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.13 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

3.14 MANUALS

- A. Operating and Maintenance (O&M) manuals shall be supplied in accordance with the requirements specified herein and Appendix 11 of the Service Contract.

3.15 WARRANTIES

- A. The Company shall furnish, unless otherwise noted herein, a full one (1) year warranty for all equipment or materials furnished under this Service Contract.

END OF SECTION

SECTION 16150

INDUCTION MOTORS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The Company shall select, furnish and install all induction motors as required by the drawings and specified herein.

B. Induction motors shall be designed, built and tested in accordance with the latest revision of NEMA MG-1.

C. Related Design-Build Work Specified Elsewhere

1. Section 16050: Basic Materials and Methods
2. Section 16152: Variable Frequency Drives
3. Section 16485: Solid State, Reduced Voltage Starters

D. Installation of motors, pumps, and drivers (VFDs, starters, etc.) shall be coordinated with requirements of Division 11, Division 13, and Division 15.

1.02 SUBMITTALS

A. The Company shall submit product data on all materials in PART 2 in accordance with Appendix 5 of the Service Contract, in addition to the requirements of this section.

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor shall be submitted. The drawings and data shall include, but shall not be limited to the following.

- Name of manufacturer
- Type and model
- Voltage and number of phases
- Type of bearing and method of lubrication
- Rated size of motor, hp [kW], and service factor
- Temperature rise and insulation rating
- Full load rotative speed
- Net weight
- Efficiency at full, $\frac{3}{4}$ and $\frac{1}{2}$ load
- Full load current
- Locked rotor current
- Space heater wattage, where applicable
- RTD data, where applicable

B. Operation and Maintenance Data and Manuals: When required, adequate operation and maintenance information shall be supplied. Operation and maintenance shall be submitted in accordance with the Article 11 of the Service Contract.

Operation and maintenance manuals shall include the following:

1. Assembly, installation, alignment, adjustment, and checking instructions
2. Lubrication and maintenance instructions

3. Guide to troubleshooting
4. Parts lists and predicted life of parts subject to wear
5. Outline, cross-section, and assembly drawings, engineering data, and wiring diagrams
6. Test data and performance curves, where applicable
7. Complete operational, maintenance & technical manual

C. Spare Parts: Spare parts shall be provided as required. Spare parts shall be suitable packaged as specified herein, with labels indicating the contents of each package.

PART 2 -PRODUCTS

2.01 EQUIPMENT

Service conditions for motors shall be as required for driven equipment. Motors shall be designed for special conditions such as area classification, altitude, frequent starting, intermittent overload, high inertia, mounting configuration, or service environment as required. Manufacturer's standard motor may be supplied on appliances, tools, and unit heater, in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, totally enclosed motors are preferred and shall be furnished if offered by the manufacturer as a standard option.

A. Motors rated less than 1/2 HP shall be single-phase, 115/230 volts, 60 Hz. unless otherwise noted. Motors rated 1/2 HP and above shall be three-phase, 460 volts. 60 Hz. unless otherwise noted.

B. Unless otherwise indicated in the mechanical equipment Specifications, horizontal motors shall be totally enclosed type when installed outdoors or in damp areas, and vertical motors shall be WP1. Explosion proof motors shall be used in hazardous locations where required.

C. All 460 volt motors shall have a service factor of 1.15, and shall not be sized to operate within the service factor.

D. Insulation shall be Class F minimum for 460 volt motors and Class B for 115/230 volt motors. All motors shall be capable of operating continuously in an ambient temperature of 40°C.

E. Bearings shall be anti-friction type, grease lubricated (re-greasable) and designed for an average life of 100,000 hours as defined by AFBM. Suitable fittings shall be provided to permit conventional positive purging of old grease during re-greasing operations.

F. Locked rotor currents shall not exceed NEMA code G for motors rated 15 H.P. and above.

G. All motors shall have stainless steel nameplates with the information as required by NEMA MG1-10.38.

H. All motors rated 200 HP and above shall have one thermistor imbedded in each stator winding. Leads from each thermistor shall be brought out of a control module mounted on the exterior of the motor.

All motors rated 100 HP and above shall have the direction of rotation marked by an arrow mounted visibly on the stator frame near the terminal housing, or on the nameplate, and the leads marked for phase sequence T1, T2, T3, to correspond to the direction of rotation and supply voltage sequence.

Leads for dual-voltage rated or multi-speed motors shall be easily connected or reconnected in the terminal housing for the operating voltage or for the specified speeds. Permanent instructions for making these connections shall be furnished inside the terminal housing or on the motor frame or nameplate.

I. Motors shall be severe duty type and shall be Reliance Type XT/SXT or equal.

J. Motors rated 25 HP or greater shall be equipped with space heaters.

K. See special requirements of equipment vendors for certain motors.

L. Motors shall conform to the efficiencies as required by the Energy Policy Act of 1992. Motors shall be premium efficiency type as derived from NEMA Standard MG1-2006, Table 12-6C.

Motors shall meet the following efficiencies as a minimum:

Motor HP	Minimum Efficiency
1-2	84.0%
3-5	86.5%
7.5	89.5%
10	90.2%
15	91.0%
20	92.0%
25	92.0%
30	92.4%
40	93.0%
50	93.0%
60	93.6%
75	94.1%
100	94.1%
125	94.5%

Motor HP**Minimum Efficiency**

150

94.5%

- M. Motors shall be rated and sized for use on PWM-type Variable Frequency Drives.
- N. All motors, including those with resilient mountings, shall be furnished with a ground connection.
- O. Conduit Boxes. Externally mounted conduit boxes shall be in accordance with NEMA MG 1. The conduit boxes shall be diagonally split for easy access to the motor leads, and designed for rotation in 90-degree increments. A gasket shall be furnished between the halves of the box. Conduit openings in the main conduit box shall match the size and quantity of conduits indicated on the one line drawings.
- The main conduit box shall be sized for all indicated accessory leads. All medium voltage motors shall have conduit boxes sized for stress cones on the cable leads.
- When required, each motor shall have auxiliary terminal boxes with terminal leads grouped in boxes for all external connections. Terminal boxes shall be oversized and shall have terminals and conduit hubs sized for the cables and conduit indicated on the drawings.

Motors furnished in NEMA 320 frame series and larger shall have conduit boxes designed and constructed to permit motor removal after installation without disconnecting raceways.

When required, motor conduit boxes shall be oversized at least one size larger than NEMA standard. Size shall be increased as required for stress cone terminations and current transformers.

2.02 ACCESSORIES

- A. Special Tools and Accessories. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Each motor shall be provided with lifting eyebolts or lugs, and appropriate fittings for adding bearing lubricant when required. Grease lubricated units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.
- B. ANCHORS. When required, Company shall furnish suitable anchors for each item of equipment as required for driven equipment.
- C. SHOP PAINTING. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for coating. Electric motors shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.
- D. BALANCE. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits as required. At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide all the equipment installations and wiring installations, including connections as indicated, specified and required.
- B. Provide power, control, alarm and grounding installations for all motors as indicated and required.
- C. Check all connections and provide correct rotation for all motors.
- D. Record each motor full load current and the overload protection rating in each starter for the certified data submittal.
- E. Provide the required wiring for all control equipment that shall be furnished and installed under other sections of the specifications.
- F. Install local control stations and equipment on stainless steel stanchions or building structures near the motors as shown on the drawings.

END OF SECTION

SECTION 16152
VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. This Section outlines the electrical work for variable frequency drive equipment.

1.02 SCOPE

- A. The Company shall furnish and install complete variable frequency drives (VFDs), isolation transformers and filters as described in this specification and as detailed on the applicable drawings or as required.
- B. The VFDs required under this section shall be the low voltage, voltage source inverter, pulse width modulated type supplied with external 12-pulse isolation transformers. The variable frequency drives shall be customized as described in this specification and as detailed on the applicable drawings or as required.
- C. The Company shall be responsible for the installation, and start-up of the equipment covered by this specification.
- D. The VFDs shall be furnished by a single manufacturer who has actively been manufacturing variable frequency drives in the United States for a period of at least five (5) years. The VFDs shall be Yaskawa P7 drives, or equal as approved by the City Engineer. Substitution of equivalent products by other manufacturers must be approved by the City Engineer and City at least 14 days prior to the original advertised bid opening date. Time and Expenses incurred by the City Engineer for reviewing or equal submittals shall be charged to the Company at no additional cost to the City. Company Must submit a line-by-line comparison of features for an "or equal" submittal.
- E. Complete drawings shall be furnished for approval and shall consist of master wiring diagrams, elementary or control schematics, including coordination with other electrical control devices operating in conjunction with each VFD. Suitable outline drawings showing details necessary to locate conduit stub ups and field wiring shall be furnished for approval before proceeding with manufacture.
- F. The VFDs shall be UL certified and shall comply with the latest applicable standards of ANSI, IEEE and NEMA. The drives shall be rated as shown on the drawings. As a minimum the full load output current of the controller shall be equal to the equivalent motor horsepower as listed by National Electric Code Table 430-150.
- G. The manufacturer shall furnish to the City Engineer a factory test report for each VFD. Refer to Part 3 - Execution, of this section. The VFD manufacturer shall use a shop test facility that has recently calibrated testing apparatus and qualified, experienced technicians, for all shop tests. Calibration dates for testing apparatus shall be within one year.
- H. Voltage and current distortion Limits shall comply to the recommendations of IEEE-519.

- I. Electromagnetic Interference Limitations.
 - 1. EMI (electromagnetic interference) and RFI (Radio frequency interference) created by the specified VFDs shall be limited as far as possible to allow proper operation of all project equipment as well as to prevent interference with any equipment utilized beyond the boundaries of the treatment plant.
 - 2. EMI and RFI produced by the specified VFDs shall be limited by all means possible including filters to limits defined in Federal Communications Commission (FCC) Rules and Regulations Volume 2 Part 15, Subpart J Class A.
- J. Powerline disturbances shall be limited per recommendations of IEEE Standard 519 latest edition including harmonic currents at the high voltage side of utility transformers and Harmonic Voltage distortion at PCC. PCC shall be considered as the service switchboards.
- K. Company shall evaluate all system components, and provide calculations showing dominant harmonics and line notching depths. Company shall provide necessary isolation transformers, filters and other necessary components to comply with IEEE-519, latest edition.
- L. Drives shall be PWM. Inverters rated above 50 HP shall be of the 12-pulse type, minimum. Inverters rated 50 HP and below shall be supplied with 3% input line reactors.
- M. Filters , reactors, etc., shall be provided to operate in accordance with IEEE-519 where required.
- N. Manufacturer shall certify that opening of an output contactor, if any, shall not cause damage or be harmful in any way to the drive.

1.03 QUALITY ASSURANCE

- A. VFD supplier shall provide and have responsibility for the variable frequency drives, isolation transformers and harmonic filters. The VFD supplier must confirm that his equipment is completely compatible with the motors, loads, and with the electrical power system at each location. The manufacturer of the VFD shall have a permanent fully factory authorized and trained, service agent employed with a technical staff and an equipped service facility within a 100 mile radius of the project site, having all personnel and all equipment required to maintain, repair, or overhaul the VFD and associated systems supplied herein.
- B. The manufacturer of the VFD system shall use components and subsystems (i.e., circuit breakers, relays, control transformers, etc.) conforming to this specification as listed elsewhere.
- C. The Systems Integrator shall coordinate the application of pumps, blowers, etc., with the drives and assure operation and system compatibility. In general, the loads are variable torque. However, loads such as positive displacement pumps shall require constant torque drives.

1.04 SUBMITTALS

- A. Materials List. The materials list shall be complete and include all products in this Section, including the equipment that shall have shop drawings. The list shall include only one manufacturer for each type of product.
- B. Shop Drawings. The shop drawings for the automatic variable frequency drive equipment shall be complete and shall include the following:

1. Plans showing the floor space requirements, clearance, conduit, and anchor bolt locations.
 2. Details showing the required enlarged views of small parts.
 3. Diagrams showing the equipment, equipment locations, wiring circuits schematics, voltage, wire numbers, and identified terminals.
 4. Connection and schematic wiring diagrams for each equipment showing numbered terminal points and wires and interconnections to other units and/or remote devices.
 5. A complete bill of material and complete catalog information of all components contained in the equipment including manufacturer's name and model numbers.
 6. Panel layouts including elevation of front, elevation of front with cover open, and nameplate inscriptions. Layout drawings shall be of sufficient size to determine adequacy of equipment.
 7. Dimensions of the equipment.
 8. Weights of the equipment.
 9. Nameplate Data including the nameplate material, height of letters, number of lines, inscriptions, and dimensions.
- C. Technical Data. Submit complete system and equipment description including detailed draft theory of operation and operation data to the Contract Administrator with copy to City Engineer with shop drawings. To be included in the final version in the Operation and Maintenance Manuals.
- D. Parts Lists. Submit to Contract Administrator with copy to City Engineer with the shop drawings a complete, priced list of parts that would be necessary to maintain and service the equipment.
- E. Factory Test Reports. Submit manufacturer's certified factory test reports to the Contract Administrator with copy to City Engineer.
- F. Document son Manufacturer's letterhead certifying the VFD proposed meets or exceeds 25 years mean time between failure (MTBF) quality.
- G. Manufacturer's Certified Reports. Submit a notarized written report from the equipment manufacturer with respect to his equipment certifying that (1) the equipment has been properly installed, wired, and connected under his supervision, (2) the equipment is in accurate alignment, (3) he was present when the equipment was placed in operation, (4) he has checked, inspected, and adjusted the equipment as necessary, (5) the equipment has been operated satisfactorily under all system conditions and (6) the equipment is fully covered under the terms of the guarantee.
- G. Furnish Operation and Maintenance Manuals in accordance with General Requirements.

1.05 WARRANTY

- A. With respect to equipment, guarantee shall cover (1) faulty or inadequate design; (2) improper assembly or erection; (3) defective workmanship or materials; and (4) incorrect or inadequate operation, or other failure. For equipment bearing a manufacturer's warranty in excess of 1 year, furnish a copy of the warranty to the Contract Administrator with copy to City Engineer with City named as beneficiary.

PART 2 - VARIABLE FREQUENCY DRIVES

2.01 CONSTRUCTION AND CHARACTERISTICS

- A. Each VFD shall provide constant volts per hertz excitation for its respective motor up to 60 Hertz.
- B. The VFDs shall have a 110 percent current rating for one minute for variable torque loads and 150 percent current rating for one minute for constant torque loads.
- C. The VFDs shall be capable of converting incoming three phase, 480V (+10 percent to -10 percent), 60 hertz (± 2 hertz) power to a dc bus level. The dc voltage shall be inverted to an adjustable frequency output. The controller shall maintain displacement power factor at .95 or greater at any speed or load. The VFDs shall have a minimum efficiency of 96 percent at rated load.
- D. The VFDs shall operate in an ambient temperature of 0 Degree C to 40 Degrees C, and humidity of 0 to 95 percent.
- E. Each VFD enclosure shall be NEMA 1 unless otherwise indicated, and the VFDs shall be wall or floor mounted.
- F. All enclosures shall be not less than 16-gauge steel with surfaces thoroughly cleaned and phosphatized prior to painting. They shall be primed with a corrosion-resisting coating. Cabinet finish paint to be ASA 61 Gray.
- G. The operating handle of the disconnect shall always remain connected to the breaker or switch and shall not be mounted on the door. The position handle shall indicate On, Off or Tripped condition of the circuit breaker. The handle shall have provisions for padlocking in the off position with at least three padlocks. Interlock provisions shall prevent unauthorized opening or closing of the VFD door with the disconnect handle in the on position. Coordinate the size and characteristics of the switchboard or MCC feeder breaker with the drive requirements.
- H. The following standard basic control features shall be provided on each VFD:
 - 1. Terminations for all required door and/or remote mounted devices.
 - 2. Linear independent time acceleration and deceleration adjustments.
 - 3. Output frequency range of 4-60 hertz, factory set.
 - 4. Frequency stability of 0.5 percent for 24 hours with voltage regulation of ± 2 percent of maximum rated output voltage.
 - 5. Control power transformer, 480-120 volt for operator devices.
 - 6. All terminals necessary for customer permissive contacts and required interlocking as required by the drawings.
 - 7. Fully digital regulator with microprocessor control of frequency, voltage, and current.
 - 8. The drive shall be designed to protect itself against instantaneous current levels above 150% of its rating. The drive shall continue to operate through instantaneous current spikes below 150%.
 - 9. The drive shall not be sensitive to line notching from other drives.
 - 10. The drive shall be capable of riding through a momentary power outage of 30 cycles without causing the drive to shut down.

11. The drive shall actively monitor its output current and frequency and if the motor is in a stall condition the drive will shut down. A stall condition is defined as operating in current limit at or below 10 Hertz for 10 seconds. This definition of stall shall be field adjustable to match the application.
 12. The minimum acceptable efficiency shall be 96% at full load.
 13. The deceleration rate shall be constant and independent of motor speed.
 14. The inrush current shall be limited to 150% of the full load current.
- I. The following standard independent adjustments shall be provided on the each VFD:
1. Minimum speed - 4 to 40 hertz.
 2. Maximum speed - 40 to 90 hertz (factory set for 60 hertz).
 3. Acceleration - .5 to 30 hertz per second with ranges of 2-120 seconds for 0-60 Hz.
 4. Deceleration - .5 to 30 hertz per second with ranges of 2-120 seconds for 0-60 Hz.
 5. Low frequency boost - up to 60 Volts at 4 hertz.
 6. Volts per hertz - Adjustable from 3.83 to 11.5 volts per hertz.
 7. Stability.
 8. Output signal of 4-20 ma dc, proportional to VFD output frequency including gain and bias adjustments.
 9. Controller status relay with two Form C relay pairs, rated 2 amps resistive at 115 Volt ac for indication of running condition.
 10. Laminated plastic nameplate engraved with customer's identifying name or number of each VFD.
- J. The following modifications shall be furnished with each VFD:
1. Full time adjustable current limit shall sense an overload on the motor when current exceeds a preset limit. Output frequency and therefore motor speed shall be reduced. If current decreases with speed, the speed shall decrease until current drops below the limit. Once current is reduced to normal, the frequency shall return to the original setting.
 2. AC output contactor and interposing control logic.
 3. Motor overcurrent relay, wired to stop unit upon trip, manually reset.
 4. Isolated signal follower for use with grounded input signal (4-20 mADC) for control of VFD output frequency. (where required).
 5. Output load ammeter, voltmeter and speed indicating meters.
 6. Door-mounted NEMA 1 or as indicated operator controls with heavy duty industrial rated devices as shown on drawings.
 7. "Hand-Off-Auto" reference selector switch to enable operator to select the speed control means from the process follow (auto) or from a manual potentiometer (hand) (where required).
 8. Digital display for monitoring the following functions:
 - a. Drive output frequency.
 - b. Motor Load calibrated in amps.
 - c. Drive output power in Kw.
 - d. Drive output voltage in Volts.
 - e. Over current.

- f. Under Voltage.
 - g. Over Voltage.
 - h. Fault diagnostic messages (system, board, component level).
- K. The following protective features shall be provided on each VFD:
 - 1. Input ac circuit breaker with an interlocked, padlockable handle mechanism.
 - 2. AC input line current limiting fuses for fault current protection of ac to dc converter section.
 - 3. Electronic overcurrent trip for instantaneous overload protection.
 - 4. AC input line undervoltage and phase loss protection.
 - 5. Overfrequency protection.
 - 6. Overtemperature protection.
 - 7. Overvoltage protection.
 - 8. Low logic supply protection.
 - 9. Electrical isolation between the power and logic circuits, as well as between the 115 Volt ac control power and the static digital sequencing.
 - 10. Ability to withstand output terminal line-to-line short circuits without component failure.
 - 11. Supply Voltage phase loss.

For any protective condition, the VFD shall trip and an internal fault relay contact shall close for remote indication.

- L. RFI and EMI. RFI filters are required. The adjustable frequency drive system shall contain all necessary filters and devices, and be constructed and installed in manner, to eliminate significant levels of conducted and radiated electrical noise. The EMI and RFI emissions from the variable frequency drive system shall not exceed the levels specified in FCC Rules and Regulations, Volume 2, Part 15, Subpart J, Class A. If after installation, any interference or noise occurs, the supplier shall take corrective action by installing whatever additional equipment or corrective measures that may be required, at no additional cost to the County. The conductors between the drive and the motor shall be shielded or installed in steel conduit as needed.
- M. Replaceable Parts. Each replaceable part including one each of printed circuit boards, plug-in modules, module assemblies, and three each of each type of diode, SCR or transistor, fuse, light, etc., not mounted on a provided assembly shall be supplied in the manufacturer's original cartons, clearly marked by name and part number as referenced in the maintenance manual. A list of such parts with prices shall be submitted with the shop drawings. The above shall exclude power transformers, chokes, contactors, which shall have a mean time between failures (MTBF) of 100,000 hours minimum.
- N. The drive shall be provided with surge and lightning protection.
- O. Parameter Settings
 - 1. The following system configuring settings, shall be provided, without exception, field adjustable through the keypad/display unit or via the serial communication port only.
 - a. Motor Nameplate Data
 - 1. Motor frequency
 - 2. Number of poles

3. Full load speed
4. Motor volts
5. Motor full load amps
6. Motor KW
7. Current limit, min.
8. Current limit, max.
- b. VFD Limits
 1. Independent accel/decel rates
 2. Motor flux build-up delay: time/amount
 3. Vmin, Vmax, V/Hz
 4. I boost
 5. Overload trip curve select (Inverse or Constant)
 6. Min/Max speed (frequency)
 7. Auto reset for load or voltage trip select
 8. Slip compensation
 9. Catch-A Spinning-Load select
 10. Overload trip time set
- c. VFD Parameters
 1. Voltage loop gain
 2. Voltage loop stability
 3. Current loop stability
- d. Controller Adjustments
 1. PID control enable/disable
 2. Setpoint select
 3. Proportional band select
 4. Resent time select
 5. Rate time select
 6. Input signal scaling
 7. Input signal select (4-20mA/0-5 Volts)
 8. Auto start functions: On/Off, Delay On/Off, Level Select On/Off
 9. Speed Profile: Entry, Exit, Point Select
 10. Min, Max Speed Select
 11. Inverse profile select (allows VFD speed to vary directly or inversely with input signal)
2. All drive setting adjustments and operation parameters shall be stored in a parameter log which lists allowable maximum and minimum points as well as the present set values. This parameter log shall be accessible via a RS232 serial port as well as on the keypad display.

P. Diagnostic Features and Fault Handling

1. The VFD shall include a comprehensive microprocessor based digital diagnostic system which monitors its own control functions and display faults and operating conditions. Microprocessor systems must be products of the same manufacturer as the VFD (to assure single source

single source responsibility, availability of service and access to spare parts).

2. A "FAULT LOG" shall record, store, display and print upon demand, the following for the 10 most recent events:
 - a. VFD mode (Auto/Manual)
 - b. Elapsed time (since previous fault)
 - c. Type of fault
 - d. Reset mode (Auto/Manual)
 3. A "HISTORIC LOG" shall record, store, display and print upon demand, the following control variables at 2 to 8 M/Sec. intervals for the 50 intervals immediately preceding a fault trip:
 - a. VFD mode (manual/auto/inhibited/tripped/etc.)
 - b. Speed demand
 - c. VFD output frequency
 - d. Demand (output) Amps
 - e. Feedback (motor) Amps
 - f. VFD output volts
 - g. Type of fault
 - 1) Br Over Current
 - 2) Br Under Voltage
 - 3) Br Phase Rotation
 - 4) Br Fuse Failure
 - 5) Sustained Overload
 - 6) Manual Trip Test
 - 7) Power Supply Fail
 - 8) Output Over Voltage
 - 9) Inverter Over Temperature
 - 10) Thermistor Trip
 - 11) Ground Fault
 - h. Drive inhibit (On/Off)
 4. The fault log record shall be accessible via a RS232 serial link as well as line by line on the keypad display.
- Q. A portable battery powered printer with RS-232C serial interface and connecting cable shall be furnished. The printer shall have a dot matrix format with a print speed of 37 CPS and a 1500 line print capability per battery charge. Operating life shall be at least 500,000 lines. A laptop computer capable of downloading, storing and printing the information may be substituted.
- R. Drives for blowers, positive displacement pumps and other constant torque loads shall be the constant torque type.

PART 3 - EXECUTION

3.01 FACTORY TESTING

- A. The VFD manufacturer shall provide the following quality assurance steps within his factory:
 1. Incoming inspection of all components.
 2. In-process inspection of assemblies.
 3. Quality Assurance program that meets or exceeds DOD Standard Audit MIL-45208.
 4. MIL STD-105D AWL 1% sampling.

5. MIL STD-C45662 calibration.
6. 100% test and inspection of power devices.

- B. The VFD manufacturer shall provide certification that the tests have been completed.
- C. The VFD printed circuit boards shall be tested at 50°C for 50 hours.
- D. The completed VFD shall be operated on an unloaded motor of suitable horsepower rating.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions and recommendations.
- B. Install so that sufficient access and working space is provided for ready and safe operation and maintenance.
- C. Install on concrete pads at locations shown on the Plans. Install support channels in concrete per manufacturer's recommendations.

3.03 START-UP

- A. Perform operation sequence of operations test to assure proper function of logic, as described.
- B. Site Testing of Each Variable Frequency Drive
 1. Each VFD shall be functionally tested with its designated motor after installation at the pump station. All VFD parameters including the following shall be tested:
 - Input Current - (b. and c. apply)
 - Input Voltage - (b. and c. apply)
 - Input Frequency - (c. applies)
 - Output Current - (b. and c. apply)
 - Output Voltage - (b. and c. apply)
 - Output Frequency - (c. applies)
 - Acceleration Rate
 - Deceleration Rate
 - Power factor at VFD Input
 2. Each phase shall be tested.
 3. Test at 15 Hz, 30 Hz, 45 Hz and 60 Hz.
 4. Miscellaneous field tests or check shall include as a minimum, the following:
 1. Check all terminations
 2. Check grounding
 3. Bump motor to verify rotation
 4. Check all run lights, switches, fail lights, alarm lights, reset buttons, meters, speed potentiometers, etc.
 5. Check (as far as possible) to determine if protective devices and features are functioning
 5. A typed and signed report of all tests and checks performed shall be provided.
 6. Tests shall be performed by a representative of the VFD manufacturer.

3.03 HARMONICS TESTING OF POWER SYSTEMS

- A. The harmonics analysis shall be provided by an independent firm specializing in this type of analysis, such as Engineering Design Technologies, Tampa, Florida or approved equal. Harmonic analysis performed by the VFD manufacturer, distributor or representative is not acceptable.
- B. Testing
 - 1. After installation of VFDs and associated equipment, the 480V power systems shall be tested for harmonics, for line notching and for RFI/EMI in cable circuits and in air.
 - 2. Test shall be performed during normal plant operation.
 - 3. Test shall be performed with each VFD operating at 0 Hz, 30 Hz, and 60 Hz.
 - 4. Test shall be performed with all VFDs operating 0 Hz, 30 Hz, and 60 Hz.
- C. Test Data. The following test data shall be provided for each test condition. Data shall be in the form of copies of print-outs from the testing unit. Test data required is:
 - 1. VFD output voltage for each phase of each drive
 - 2. VFD output current for each phase of each drive
 - 3. Distribution switchboard, voltage for each phase
 - 4. VFD input voltage for each phase (for one VFD of each size) in each location
 - 5. VFD input current for each phase (for one VFD of each size) in each location
 - 6. Isolation transformer input current for each phase (for one VFD for each size)
 - 7. Generator output current for each phase of each generator
 - 8. Voltage and current for each phase at the input side of the utility transformer
- D. Special Data
 - 1. Total harmonic distortion of each current and voltage listed above shall be calculated, listed and compared to IEEE Std. 519 recommendations and Section 1.03.A. requirements.
 - 2. Line notch parameters for each voltage waveform shall be calculated, listed and compared to IEEE Std. 519 recommendations and those of Section 1.03.A.
 - 3. Measurements of EMI/RFI in air and in power cables shall be measured and listed.
- E. Data Submission. All test data and special data shall be submitted for review by the Contract Administrator with copy to City Engineer.
- F. The Company shall provide necessary corrections for compliance to IEEE 519 recommendations where necessary.

3.04 FIELD QUALITY CONTROL

- A. Make the following field tests and checks after installation:
 - 1. Check all terminations
 - 2. Check all grounding
 - 3. Verify pump motor rotation
 - 4. Check all run lights, switches, fail lights, alarm lights, reset buttons, meters, speed potentiometers, etc.
 - 5. Check protective devices are functioning.

- B. Perform system validation tests as specified in other sections of this specification.

3.05 FIELD PAINTING

- A. Touch-up field damaged factory finishes with paint that matches the original equipment finish.

3.06 OPERATING INSTRUCTIONS

- A. One set of operating instructions for the system (laminated 11x17) shall be posted directly beside the control panel. As-built ladder diagram and a functional description shall be posted inside the control panel main door for troubleshooting. Three complete sets of documentation shall be supplied to the City.

3.07 TRAINING – NOT USED

3.08 SPARE PARTS

- A. A spare parts list including original device manufacturer's part numbers for cross-referencing purposes shall be furnished. Lists containing only the VFD manufacturer's part numbers are not acceptable.
- B. Provide VFD drive spare parts. Each spare part set shall consist of the manufacturer's recommended spare parts inventory and shall include at a minimum the following:
 - 1. One set of transistor and diode modules with accessories.
 - 2. One power supply module.
 - 3. One set of fans.
 - 4. One set of power fuses of each size and type used.
 - 5. Two sets of control power fuses of each type and size used.
 - 6. One pilot light of each type used.
- C. The spare parts shall be listed in an index and packed in containers suitable for long term storage bearing labels clearly designating the manufacturer's part number with complete information for use and reordering.

END OF SECTION

SECTION 16410
AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.01 SCOPE

- A. Design-Build Work includes low-voltage, automatic transfer switches and associated auxiliary equipment rated 600 V or less.
- B. Related Design-Build Work specified elsewhere.
 - 1. Section 16010 - General Electrical Requirements.
 - 2. Section 16050 - Basic Electrical Materials and Methods.
 - 3. Section 16620 – Stationary Power Standby Generator System - Diesel

1.02 QUALITY ASSURANCE

- A. Standards Compliance. Materials or equipment must conform to the following standards:
 - 1. UL 1008 – Standard for Automatic Transfer Switches
 - 2. NFPA 70 – National Electric Code
 - 3. NFPA 110 – Emergency and Standby Power Systems
 - 4. NEMA Standard ICS10-P1:2005 – Industrial Control and Systems Part 1: Electromechanical AC Transfer Switch Equipment

1.03 SUBMITTALS

- A. General: The Company shall submit the following in accordance with Appendix 5 of the Service Contract.
- B. Shop Drawings:
 - 1. Descriptive product information, including component and device lists
 - 2. Dimensional drawings, including elevations
 - 3. Operational description
 - 4. Anchoring instructions and details
 - 5. Connection and interconnection drawings
 - 6. Conduit entrance locations
- C. Maintenance data for materials and products, for inclusion in Operating and Maintenance Manual specified in Appendix 11 of the Service Contract.
- D. Quality Control Submittals

1. Manufacturer's installation instructions
2. Certified Factory Test Report
3. Operation and Maintenance Manual
4. Manufacturer's Certification of Proper Installation: The Company shall submit to the Contract Administrator with copy to the City Engineer manufacturer's certificates of conformance of compliance for the Manual Transfer Switch specified to conform to publications referenced in this section.
5. Proof of material or equipment conformance, in the form of a standard label or certificate of compliance from the manufacturer, shall be submitted to the Contract Administrator with copy to the City Engineer for approval. The certificate shall identify the manufacturer, the product, and the referenced standard and shall simply state that the manufacturer certifies that the product conforms to all requirements of the project Specification and of the referenced standards listed.

1.04 DELIVERY AND STORAGE

- A. Equipment and materials shall be carefully handled, properly stored, and adequately protected to prevent damage before and during installation, in strict accordance with the manufacturer's recommendations, and as approved by the City Engineer. Items damaged or defective in the opinion of the City Engineer shall be replaced.

1.05 MATERIALS AND WORKMANSHIP

- A. All materials and equipment shall be new, unused, and suitable for the service intended. Workmanship shall be of the highest quality, performed by skilled and experienced workmen. Materials and equipment shall be catalogued, standard products of manufacturers regularly engaged in the production of such materials or equipment and shall be manufacturer's latest design that complies with the Specification requirements. Materials and equipment shall duplicate items that have been in satisfactory commercial or industrial use at least two years prior to BID opening. Where two or more items of the same class of equipment are required, these items shall be products of a single manufacturer. Each item of equipment shall have the manufacturer's name, address, model number, and serial number on the nameplate securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.06 SAFETY REQUIREMENTS

- A. Belts, pulleys, chains, gears, couplings, projecting setscrews, keys, and other rotating parts; high temperature equipment or piping; and, electrical equipment, located so that a person can come in proximity thereto, shall be fully enclosed or properly guarded. All provisions of the Occupational Safety and Health Administration (OSHA) shall be complied with in satisfying this requirement.

1.07 MANUFACTURER'S RECOMMENDATIONS

- A. Where installation procedures are required to be in accordance with the recommendations of the manufacturer of the material or equipment being installed, printed copies of these recommendations shall be furnished to the Contract Administrator with copy to the City Engineer. Failure to furnish these recommendations can be cause for rejection of the material.

1.08 ELECTRICAL REQUIREMENTS

- A. Electrical components of mechanical equipment and systems, such as controls, shall be provided as specified herein as necessary for complete and operable systems. Interconnecting wiring for components of packaged equipment shall be provided as an integral part of the equipment. All interconnecting power wiring and conduit for field erected equipment, all control wiring rated over 100 Volts and conduit, and all control wiring rated under 100 Volts and conduit shall be as specified herein and conform with all applicable IEEE and NEC standards.

1.09 SPECIAL TOOLS, SPARE PARTS AND LUBRICATION

- A. The Company shall provide, as part of his Bid, all special tools required for normal maintenance and inspection of all equipment. The Company shall also provide one (1) complete set of spare parts as recommended by the equipment manufacturer.

1.10 WARRANTY

- A. The transfer switch shall have a two-year warranty on all labor and parts.

PART 2 - PRODUCTS

2.01 TRANSFER SWITCH RATING

- A. The new transfer switch shall be rated for 480 VAC, three-phase, 60 cycle and shall have 600 volt insulation on all parts in accordance with NEMA standards. Ampere rating shall be as indicated on the Drawings.
- B. The current rating shall be 24 hour continuous rating when the switch is enclosed in an unventilated enclosure, and shall conform to NEMA temperature rise standards.
- C. The current rating shall be based on all classes of loads, i.e., resistive, tungsten, ballast and inductive loads. The switches shall be U.L. listed for 100 percent tungsten lamp load.
- D. As a precondition for approval, the transfer switch, complete with accessories, shall be listed by Underwriters' Laboratories, and approved for use on Emergency Systems.
- E. The thermal capacity of the main contacts shall be not less than 20 times the continuous duty rating for a minimum of three electrical cycles as established by certified test data.
- F. Temperature rise shall be in accordance with UL-1008 except that it shall be conducted at the conclusion of the overload and endurance tests.

2.02 CONSTRUCTION AND PERFORMANCE

- A. The automatic transfer switch shall be double throw construction operated by a reliable electrical mechanism momentarily energized. There shall be a direct mechanical coupling to facilitate transfer. Transfer switch shall be service entrance rated.

- B. The transfer switches shall be provided with a drawout mechanism to allow easy access for preventive maintenance, testing or inspection. The drawout mechanism shall provide visual indicators as to the position of the switch/breaker during the drawout operation.
- C. The normal and emergency contacts shall be mechanically interlocked such that failure or disarrangement of any part shall not permit a neutral position.
- D. The transfer switch shall be controlled by a microprocessor-based controller. The controller shall be hardened against potential problems from transients and surges. Operation of the transfer switch and monitoring of both sources shall be managed by the controller.
- D. The contact structure shall consist of a main current carrying contact which is a silver alloy with a minimum of 50 percent silver content. The main current carrying contacts shall be protected by refractory arcing contacts on all sizes.
- E. The transfer switch manufacturer shall submit test data for each size switch, showing it can withstand, without damage, fault currents of the magnitude and the duration necessary to maintain the system integrity.
- F. A dielectric test at 1960 volts minimum at the conclusion of the withstand and closing tests shall be performed.
- G. The transfer switch manufacturer shall certify sufficient arc interrupting capabilities for 50 cycles of operation to operate between a normal and emergency source that are 120 degrees out of phase at 480 volts for the following load current and power factors:
 - 600 percent of nominal at .50 power factor
 - 20 percent of nominal at .50 power factor

The above certification is to insure that there will be no current flow between the two isolated sources during switching.

- H. All relays shall be continuous duty industrial type with wiping contacts. All interface contacts shall be rated 10 amperes, minimum.
- I. All coils, relays, timers and accessories shall be readily front accessible.
- J. Main and arcing contacts shall be fully visible without major disassembly to facilitate inspection and maintenance.
- K. A manual operating handle shall be provided for maintenance purposes. The handle shall permit the operator to manually stop the contacts at any point throughout their entire travel to inspect and service the contacts when required.
- L. The switch shall be mounted in a suitable stainless steel NEMA 12 enclosure.
- M. Designs utilizing components of molded-case circuit breakers, contactors, or parts thereof which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not acceptable.
- N. Where neutral conductors must be switched, the ATS shall be provided with fully rated neutral transfer contacts.

- O. Where neutral conductors are to be solidly connected, a neutral terminal plate with fully-rated AL-CU pressure connectors shall be provided.

2.03 ACCEPTABLE MANUFACTURERS

- A. The automatic transfer switch shall be as manufactured by ASCO, or equal.

PART 3 - EXECUTION

3.01 PRE-SHIPMENT TESTING

- A. Prior to shipment, the Transfer Switch shall be tested in the factory to assure conformance with these specifications. The Company shall furnish a certified report that such testing has been conducted prior to shipment.

3.02 INSTALLATION

- A. Company shall install and test all items associated with the Automatic Transfer Switch in accordance with manufacturer's written instructions.

END OF SECTION

SECTION 16426
METAL-ENCLOSED DRAWOUT SWITCHGEAR– LOW VOLTAGE

PART 1 - GENERAL

1.01 SCOPE

- A. The Company shall furnish and install, where indicated on the drawings, a deadfront type, low voltage, metal-enclosed switchgear assembly, as specified herein and shown on the contract drawings.

1.02 RELATED SECTIONS

- A. Section 16010 – Electrical General Requirements.
- B. Section 16050 – Basic Electrical Materials and Methods.
- C. Section 16709 – Transient Voltage Surge Suppression Systems.

1.03 REFERENCES

- A. The low voltage metal-enclosed switchgear assembly and all components shall be designed, manufactured and tested in accordance with the following latest applicable standards:
 - 1. ANSI-C12.1 – Code for Electricity Metering
 - 2. ANSI-C37.20 – Switchgear assemblies
 - 3. ANSI-C37.13 – Low voltage power circuit breakers
 - 4. ANSI-C37.17 – Trip devices
 - 5. NEMA SG-5 – Switchgear assemblies
 - 6. NEMA SG-3 – Low voltage power circuit breakers
 - 7. UL 50 – Cabinets and Boxes
 - 8. UL 1558

1.04 SUBMITTALS – FOR REVIEW/APPROVAL

- A. The following information shall be submitted to the Contract Administrator with copy to the City Engineer:
 - 1. Master drawing index
 - 2. Front view and plan view of the assembly
 - 3. Three-line diagram
 - 4. Schematic diagram
 - 5. Nameplate schedule
 - 6. Component list
 - 7. Conduit space locations within the assembly
 - 8. Assembly ratings including:
 - a. Short-circuit rating

- b. Voltage
 - c. Continuous current rating
- 9. Major component ratings including:
 - a. Voltage
 - b. Continuous current rating
 - c. Interrupting ratings
- 10. Cable terminal sizes
- 11. Product data sheets

B. Where applicable, the following additional information shall be submitted to the Contract Administrator with copy to the City Engineer:

- 1. Busway connection
- 2. Composite front view and plan view of close-coupled assemblies
- 3. Key interlock scheme drawing and sequence of operations
- 4. Mimic bus size and color

1.05 SUBMITTALS – FOR CONSTRUCTION

A. The following information shall be submitted for record purposes:

- 1. Final as-built drawings and information for items listed in Paragraph 1.04, and shall incorporate all changes made during the manufacturing process
- 2. Wiring diagrams
- 3. Certified production test reports
- 4. Installation information
- 5. Seismic certification as specified

1.06 QUALIFICATIONS

- A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the City Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.07 REGULATORY REQUIREMENTS

- A. The switchgear shall bear a UL 1558 label. Certified copies of production test reports shall be supplied demonstrating compliance with these standards.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

- B. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.
- C. Inspect and report concealed damage to carrier within their required time period.
- D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.
- E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.09 OPERATION AND MAINTENANCE MANUALS

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped, and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Eaton / Cutler-Hammer products.
- B. Square D.
- C. GE.
- D. Or equal.

2.02 RATINGS

- A. Voltage rating shall be as indicated on the drawings. The entire assembly shall be suitable for 600 volts maximum ac service.
- B. The assembly shall be rated to withstand mechanical forces exerted during short-circuit conditions when connected directly to a power source having available fault current as shown on the drawings.
- C. The bus system shall have a minimum ANSI short-circuit withstand rating of 100,000 amperes symmetrical tested in accordance with ANSI C37.20.1 and UL1558.
- D. All circuit breakers shall have a minimum symmetrical interrupting capacity of 65,000 amperes. To ensure a fully selective system, all circuit breakers shall have 30 cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 85,000 amperes, regardless of whether equipped with instantaneous trip protection or not.

- E. All ratings shall be tested to the requirements of ANSI C37.20.1, C37.50 and C37.51 and UL witnessed and approved.

2.03 CONSTRUCTION

- A. The switchgear shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure. The rear covers shall be fabricated in two (2) pieces for ease of handling and shall be mounted using captive hardware.
- B. The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to Company supplied concrete maintenance pad per manufacturer's recommendations. Provisions shall be made for jacking of shipping groups, for removal of skids or insertion of equipment rollers. Base of assembly shall be suitable for rolling directly on pipes without skids. The base shall be equipped with slots in the base frame members to accommodate the use of pry bars for moving the equipment to its final position.
- C. Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment and a rear cable compartment. Each individual circuit breaker compartment, or cell, shall be segregated from adjacent compartments and sections by means of steel barriers to the maximum extent possible. It shall be equipped with drawout rails and primary and secondary disconnecting contacts. Removable hinge pins shall be provided on the breaker compartment door hinges. Current transformers for feeder instrumentation, where shown on the plans, shall be located within the appropriate breaker cells and be front accessible and removable.
- D. The stationary part of the primary disconnecting devices for each power circuit breaker shall be breaker mounted and consist of a set of contacts extending to the rear through a glass polyester insulating support barrier; corresponding moving finger contacts, suitably spaced, shall be furnished on the power circuit breaker studs which engage in only the connected position. The assembly shall provide multiple silver-to-silver full floating high pressure point contacts with uniform pressure on each finger maintained by springs. Each circuit shall include the necessary three-phase bus connections between the section bus and the breaker line side studs. Load studs shall be equipped with insulated copper load extension buses terminating in solderless type terminals in the rear cable compartment of each structure. Bus extensions shall be either silver or tin-plated where outgoing terminals are attached.
- E. The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door: lever circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit, and read circuit breaker rating nameplate.
- F. The secondary disconnecting devices shall consist of floating terminals mounted on the stationary unit and engaging mating contacts at the front of the breaker. The secondary disconnecting devices shall be gold-plated and engagement shall be maintained in the "connected" and "test" positions.
- G. The removable power circuit breaker element shall be equipped with disconnecting contacts and interlocks for drawout application. It shall have four positions, "connected," "test," "disconnected" and "removed." The breaker drawout element shall contain a worm gear leveraging "in" and "out"

mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell. Interlocking that trips the breaker will not be accepted. The breaker shall include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall provide for securing the breaker in the connected, test, or disconnected position by preventing levering.

- H. An insulating flash shield shall be mounted above each circuit breaker to prevent flashover from the arc chutes to ground.
- I. The switchgear shall be Cutler-Hammer Magnum DS low voltage metal-enclosed switchgear, utilizing Magnum DS power circuit breakers as herein specified, or equal.

2.04 BUS

- A. All bus bars shall be either silver or tin-plated copper. Main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Bus sizing shall be based on ANSI standard temperature rise criteria of 65 degrees C over a 40 degrees C ambient (outside the enclosure).
- B. Provide a full capacity neutral bus where a neutral bus is indicated on the drawings.
- C. A copper ground bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The ground bus short-time withstand rating shall meet that of the largest circuit breaker within the assembly.
- D. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with Belleville-type washers.

2.05 WIRING/TERMINATIONS

- A. Small wiring, necessary fuse blocks and terminal blocks within the switchgear shall be furnished as required. Control components mounted within the assembly shall be suitably marked for identification corresponding to the appropriate designations on manufacturer’s wiring diagrams.
- B. Provide a front accessible, isolated vertical wireway for routing of factory and field wiring. Factory provisions shall be made for securing field wiring without the need for adhesive wire anchors.
- C. Front access to all circuit breaker secondary connection points shall be provided for ease of troubleshooting and connection to external field connections without the need of removing the circuit breaker for access.
- D. All control wire shall be type SIS. Control wiring shall be 14 ga for control circuits and 12 ga for current transformer circuits. Wire bundles shall be secured with nylon ties and anchored to the assembly with the use of pre-punched wire lances or nylon non-adhesive anchors. All current transformer secondary leads shall first be connected to conveniently accessible shorting terminal blocks before connecting to any other device. Shorting screws with provisions for storage shall be provided. All groups of control wires leaving the switchgear shall be provided with terminal blocks with suitable numbering strips and provisions for #10 AWG field connections. Each control wire shall be marked to the origin zone/wire name/destination zone over the entire length of the wire

of the wire using a cured ink process. Provide wire markers at each end of all control wiring. Plug-in terminal blocks shall be provided for all shipping split wires. Terminal connections to remote devices or sources shall be front accessible via doors above each circuit breaker.

- E. NEMA 2-hole mechanical-type lugs shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75 degrees C of the size indicated on the drawings.
- F. Lugs shall be provided in the incoming line section for connection of the main grounding conductor. Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.
- G. Reusable insulating boots shall be provided to cover all power cable terminations.

2.06 CIRCUIT BREAKERS

- A. All protective devices shall be low voltage power circuit breakers, Cutler-Hammer type Magnum DS or approved equal. All breakers shall be UL listed for application in their intended enclosures for 100% of their continuous ampere rating.
- B. All power circuit breakers shall be constructed and tested in accordance with ANSI C37.13, C37.16, C37.17, C37.50, UL 1066 and NEMA SG-3 standard. The breaker shall carry a UL label.
- C. Breakers shall be provided in drawout configuration.
- D. Breakers shall be manually operated (MO) unless electrically operated (EO) is indicated on the drawings.
- E. To facilitate lifting, the power circuit breaker shall have integral handles on the side of the breaker.
- F. The power circuit breaker shall have a closing time of not more than 3 cycles.
- G. The primary contacts shall have an easily accessible wear indicator to indicate contact erosion.
- H. The power circuit breaker shall have three windows in the front cover to clearly indicate any electrical accessories that are mounted in the breaker. The accessory shall have a label that will indicate its function and voltage. The accessories shall be plug and lock type and UL listed for easy field installation. They shall be modular in design and shall be common to all frame sizes and ratings.
- I. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions, as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a "Positive On" feature. The breaker flag will read "Closed" if the contacts are welded and the breaker is tripped or opened.
- J. The current sensors shall have a back cover window that will permit viewing the sensor rating on the back of the breaker. A rating plug will offer indication of the rating on the front of the trip unit.
- K. A position indicator shall be located on the faceplate of the breaker. This indicator shall provide color indication of the breaker position in the cell. These positions shall be Connect (Red), Test

(Yellow), and Disconnect (Green). The levering door shall be interlocked so that when the breaker is in the closed position, the breaker levering-in door shall not open.

- L. Each power circuit breaker shall offer sixty (60) front-mounted dedicated secondary wiring points. Each wiring point shall have finger safe contacts, which will accommodate #10 AWG maximum field connections with ring tongue or spade terminals or bare wire.

2.07 TRIP UNITS

- A. Each low voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker. The trip unit shall be Cutler-Hammer type Digitrip RMS 520M, or equal
- B. The trip unit shall have an information system that utilizes battery backup LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip. A test pushbutton shall energize a LED to indicate the battery status.
- C. The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.
- D. The trip unit shall be provided with a making-current release circuit. The circuit shall be armed for approximately two cycles after breaker closing and shall operate for all peak fault levels above 25 times the ampere value of the rating plug.
- E. Trip unit shall have selectable powered and unpowered thermal memory for enhanced circuit protection.
- F. Complete system selective coordination shall be provided by the addition of individually adjustable time/current curve shaping solid-state elements.
 - 1. All circuit breakers, where indicated, shall have adjustments for long delay pickup and time
 - 2. All circuit breakers where indicated, shall have individual adjustments for short delay pickup and time, and include I^2t settings
 - 3. All circuit breakers where indicated, shall have an adjustable instantaneous pickup
 - 4. Circuit breakers, where indicated on the drawings, shall have individually adjustable ground fault current pickup and time, and include I^2t settings or ground alarm only
- G. The trip unit shall have provisions for a single test kit to test each of the trip functions.
- H. The trip unit shall provide zone interlocking for the short-time delay and ground fault delay trip functions for improved system coordination. The zone interlocking system shall restrain the tripping of an upstream breaker and allow the breaker closest to the fault to trip with no intentional time

time delay. In the event that the downstream breaker does not trip, the upstream breaker shall trip after the present time delay.

- I. Circuit breakers, where indicated on the drawings, shall have individually adjustable ground fault alarm only.
- J. The trip unit shall have a 4-character LCD display showing phase, neutral, and ground current. The accuracy of these readings shall be +/- 2% of full scale.
- K. The trip unit shall be equipped to permit communication via a network twisted pair for remote monitoring and control.

2.08 CENTRAL DISPLAY UNIT

- L. Where indicated on the drawings, provide a central display unit capable of displaying information and data from trip units specified above.

2.09 MISCELLANEOUS DEVICES

- A. Key interlocks shall be provided as indicated on the drawings. These interlocks shall keep the circuit breakers trip-free when actuated.
- B. Each section of the switchgear shall be provided with a space heater thermostatically controlled. Power for the space heaters shall be obtained from a control power transformer within the switchgear. Supply voltage shall be 120 volts ac.
- C. Fused control power transformers shall be provided as indicated on the drawings or as required for proper operation of the equipment. A manual disconnect shall be provided ahead of the primary fuses. Control power transformers shall have adequate capacity to supply power to the transformer cooling fans.

2.10 CITY METERING

- A. Where indicated on the drawings, provide a separate City metering compartment with front hinged door.
- B. Provide current transformers for each meter. Current transformers shall be wired to shorting-type terminal blocks.
- C. Provide potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.
- D. Microprocessor-Based Metering System.
 - 1. Provide.

2.11 ENCLOSURES

- A. NEMA 1 Enclosure

2.12 NAMEPLATES

- A. Engraved nameplates, mounted on the face of the assembly, shall be furnished for all main and feeder circuits as indicated on the drawings. Nameplates shall be laminated plastic, black characters on white background, and secured with screws. Characters shall be 3/16-inch high, minimum.
- B. Furnish master nameplate giving switchgear designation, voltage ampere rating, short-circuit rating, and manufacturer's name.
- C. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's drawings.

2.13 FINISH

- A. All exterior and interior steel surfaces of the switchgear shall be properly cleaned and provided with a rust-inhibiting phosphatized coating. Color and finish of the switchgear shall be ANSI 61.

2.14 ACCESSORIES

- A. Provide a traveling type circuit breaker lifter, rail-mounted on top of switchgear.

2.15 TRANSIENT VOLTAGE SURGE SUPPRESSION

- A. Provide transient voltage surge suppression as specified in Section 16709.

PART 3 EXECUTION

3.01 FACTORY TESTING

- A. The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested to ensure the accuracy of the wiring and the functioning of all equipment. The main bus system shall be given a dielectric test of 2200 volts for one minute between live parts and ground and between opposite polarities.
- B. The wiring and control circuits shall be given a dielectric test of 1500 volts for one minute, or 1800 volts for one second, between live parts and ground, in accordance with ANSI C37.20.1.
- C. A certified test report of all standard production tests shall be shipped with each assembly.
- D. Factory test as outlined above shall be witnessed by the City Engineer.
 - 1. The manufacturer shall notify the City Engineer two (2) weeks prior to the date the tests are to be performed

3.02 FIELD QUALITY CONTROL

- A. Provide the services of a qualified factory-trained manufacturer's representative to assist the Company in installation and start-up of the equipment specified under this section for a period of 10 working days. The manufacturer's representative shall provide technical direction and assistance to the Company in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.
- B. The Company shall provide three (3) copies of the manufacturer's field startup report.

3.03 MANUFACTURER'S CERTIFICATION

- A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.
- B. The Company shall provide three (3) copies of the manufacturer's representative's certification before final payment.

3.04 TRAINING – NOT USED

3.05 INSTALLATION

- A. The Company shall install all equipment per the manufacturer's recommendations and the contract drawings.
- B. All necessary hardware to secure the assembly in place shall be provided by the Company.
- C. The equipment shall be installed and checked in accordance with the manufacturer's recommendations. This shall include but not limited to:
 - 1. Checking to ensure that the pad location is level to within 0.125 inches per three foot of distance in any direction
 - 2. Checking to ensure that all bus bars are torqued to the manufacturer's recommendations
 - 3. Assembling all shipping sections, removing all shipping braces and connecting all shipping split mechanical and electrical connections
 - 4. Securing assemblies to foundation or floor channels
 - 5. Measuring and recording Megger readings phase-to-phase, phase-to-ground, and neutral-to-ground (four wire systems only)
 - 6. Inspecting and installing all circuit breakers in their proper compartments

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Power system grounding
- B. Communication system grounding
- C. Electrical equipment and raceway grounding and bonding

1.02 Related sections

- A. Appendix 5 of the Service Contract – Submittals.
- B. Appendix 4 of the Service Contract. – Quality Control.

1.03 REFERENCES

- A. The following documents form a part of these specifications to the extent stated herein.
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM B 8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
 - 2. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
 - a. IEEE 80 Guide for Safety in AC Substation Grounding
 - b. IEEE 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System
 - c. IEEE 100 Standard Dictionary of Electrical and Electronic Terms
 - d. IEEE 141 Recommended Practice for Electric Power Distribution for Industrial Plants
 - e. IEEE 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems
 - 3. National Fire Protection Association (NFPA)
 - NFPA 70 National Electrical Code
 - 4. Underwriter's Laboratory (UL)
 - a. UL 467

1.04 SYSTEM DESCRIPTION

- A. Ground the electrical service system neutral in accordance with NFPA 70 at service entrance equipment to grounding grid.
- B. Ground each separately-derived system neutral in accordance with NFPA 70 to ground grid.
- C. Provide communications system grounding conductor in accordance with NFPA 70 at point of service entrance and connect to the grounding system at a single connection point.
- D. Design and install system for "single point grounding" by ensuring that all equipment has only a single ground path and that all equipment grounds in a particular structure are connected at a single common grounding point. External counterpoise ground rings shall be connected to building grounds at the single common grounding point.
- E. Design system in accordance with IEEE recommendations previously noted.
- F. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems in accordance with NFPA 70.

1.05 SUBMITTALS

- A. Submit product data under provisions of Appendix 5 of the Service Contract.
- B. Test Results: Results of testing specified in subpart 1.06C of this Section.

1.06 QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation
- B. Test resistance to earth of grounding connections in accordance with IEEE 81. Perform fall of potential test on main system. Use two points method test to determine resistance between main system and ground. Maximum Acceptable Ground Resistance: 1 ohms. Submit test results in accordance with Appendix 5 of the Service Contract.
- C. Inspect to confirm implementation of Part 3 of this Section.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 3. Apache Grounding; Nashville Wire Products.
 - 4. Boggs: H. L. Boggs & Co.
 - 5. Chance: A. B. Chance Co.

6. Dossert Corp.
7. Erico Inc.; Electrical Products Group.
8. Galvan Industries, Inc.
9. Hastings Fiber Glass Products, Inc.
10. Heary Brothers Lightning Protection Co.
11. Ideal Industries, Inc.
12. ILSCO.
13. Kearney.
14. Korn's: C. C. Korn's Co.
15. Lightning Master Corp.
16. Lyncole XIT Grounding.
17. O-Z/Gedney Co.
18. Racor, Inc.
19. Salisbury: W.H. Salisbury & Co., Utility.
20. Thomas & Betts, Electrical.
21. Utilco Co.

2.02 WIRE AND CABLE GROUNDING CONDUCTORS

- A. Comply with Division 16 Section 16050. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.
- B. Equipment Grounding Conductors: Insulated with green color insulation.
- C. Grounding-Electrode Conductors: Stranded cable.
- D. Underground Conductors: Bare, tinned, stranded, except as otherwise indicated.
- E. Bare Copper Conductors: Conform to the following:
 1. Solid Conductors: ASTM B 3.
 2. Assembly of Stranded Conductors: ASTM B 8.
 3. Tinned Conductors: ASTM B 33.

2.03 MISCELLANEOUS CONDUCTORS

- A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section.
- B. Braided Bonding Jumpers: Copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules.
- C. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, except as indicated.

2.04 CONNECTOR PRODUCTS

- A. Pressure Connectors: High-conductivity-plated units.

- B. Bolted Clamps: Heavy-duty type.
 - C. Exothermic-Welded Connections: Provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.
- 2.05 GROUNDING ELECTRODES AND TEST WELLS
- A. Grounding Rods: Sectional type; copper-clad steel. 3/4 inch by 120 inches (19 by 3000 mm).
 - B. Test Wells: Fabricate from 15-inch- (400-mm-) long, square-cut sections of 8-inch- (200-mm-) diameter, Schedule 80, PVC pipe.

PART 3 - EXECUTION

st Level 3

3.01 APPLICATION

- A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.
- B. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide a No. 4 AWG minimum insulated grounding conductor in raceway from grounding-electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
- C. Separately Derived Systems: Where NEC requires grounding, ground according to NEC Paragraph 250-26.
- D. Metal Poles Supporting Outdoor Lighting Fixtures: Ground pole to a grounding electrode in addition to separate equipment grounding conductor run with supply branch circuit.
- E. Connections to Lightning Protection System: Bond grounding conductors, including grounding-conductor conduits, to lightning protection down conductors or lightning protection grounding conductors in compliance with NFPA 780.
- F. Common Ground Bonding with Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system grounding conductor and install in conduit.

3.02 INSTALLATION

- A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.
- B. Electrical Room Grounding Bus: Space 1 inch (25 mm) from wall and support from wall 6 inches (150 mm) above finished floor, except as otherwise indicated.
- C. Grounding Rods: Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode. Drive until tops are 2 inches (50 mm) below finished floor or final grade, except as otherwise indicated. Interconnect with grounding-electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make these connections without damaging copper coating or exposing steel.
- D. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- E. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches (600 mm) below grade.
- F. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

3.03 CONNECTIONS

- A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series. Make connections with clean, bare metal at points of contact. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.
- E. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and grounding rods.
- F. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.
- G. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

- H. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.04 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

- A. Manholes and Handholes: Install a driven grounding rod close to wall and set rod depth so 4 inches (100 mm) will extend above finished floor. Where necessary, install grounding rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from grounding rod into manhole through a waterproof sleeve in manhole wall. Protect grounding rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
- B. Connections to Manhole Components: Connect exposed metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to grounding rod or grounding conductor. Make connections with minimum No. 4 AWG stranded, hard-drawn copper wire. Train conductors plumb or level around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- C. Grounding System: Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes.

3.05 FIELD QUALITY CONTROL

- A. Independent Testing Agency: Engage an independent electrical testing organization to perform tests described below.
- B. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the 2-point method according to IEEE 81.
- C. Maximum grounding to resistance values are as follows:
 - 1. Equipment Rated 500 kVA and Less: 10 ohms.
 - 2. Equipment Rated 500 to 1000 kVA: 5 ohms.
 - 3. Equipment Rated More than 1000 kVA: 3 ohms.
 - 4. Unfenced Substations and Pad-Mounted Equipment: 5 ohms.
 - 5. Manhole Grounds: 10 ohms.
- A. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify City Engineer promptly and include recommendations to reduce ground resistance and to accomplish recommended work.
- B. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

END OF SECTION

SECTION 16485

SOLID STATE, REDUCED VOLTAGE STARTERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section outlines the electrical requirement for solid state reduced voltage starters. The solid state starters shall be heavy duty, rated for the motor as shown. The solid state starters shall provide reduced voltage on-off stepless control of 3 phase induction motors via a solid-state bridge for simple, reliable and efficient, reduced voltage starting. Mechanical and magnetic type reduced voltage starters are unacceptable.
- B. The installation and startup of these starters and the driven equipment shall be coordinated by the systems integrator.

1.02 SUBMITTALS

- A. Submit to Contract Administrator with copy to the City Engineer for approval shop drawings, factory test reports, manufacturers' certified reports and technical data for solid state reduced voltage starters supplied to the extent required in this Section.
- B. Shop Drawings.
 - 1. Complete shop drawings shall be submitted for review of equipment in accordance with specifications. As a minimum, shop drawings shall include a bill of materials, front views, assembly drawings, electrical schematics, electrical connection diagrams and termination points, Starter continuous current rating, Nameplate data, Weights, and NEMA rating starter enclosures, and Speed torque/current at 100 percent volts.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Handling and shipment of the equipment shall be in such a manner to prevent internal component damage, breakage, and denting and scoring of the enclosure finish.
- B. Equipment shall be stored indoors in a clean, dry environment. Energize space heaters if furnished.

1.04 RELATED SECTIONS

- A. Section 16150 - Motors
- B. Section 16709 - Transient Voltage Surge Suppression Systems

PART 2 - PRODUCTS

2.01 GENERAL

- A. Starters shall be supplied as specified in this Section. The starters shall be completely fabricated, assembled, checked and tested at the factory. The starters shall be manufactured by MagneTek by ICon Technologies, or equal.
- B. Provide the metal enclosed solid state starter as specified and required. The starter shall be usually rated 480, 3 phase 60 hertz, heavy duty, unless otherwise indicated. Overall efficiency shall be 99.375%. As a minimum, the starter shall consist of an SCR bridge, firing circuit board, circuit breaker line and load isolation contactors, bypass shorting contactor, line and load terminals, diagnostics protection, and meters. Additional features shall be provided as required.

2.02 SCR BRIDGE

- A. SCR bridge shall be full wave consisting of 6 SCRs (Silicon Controlled Rectifiers), 2 SCRs back-to-back per phase. PIV shall be 1200 PIV at 480 vac, 1800 PIV at 600 vac. SCR voltage drop shall be 0.5V. The SCR bridge shall have a 1 cycle surge rating greater than 20 times motor FLA. The SCR bridge shall be able to operate at 500% motor FLA for 30 seconds, minimum and 125% motor FLA continuous. The bridge shall have a dielectric test strength of 2500 V minimum.

2.03 FIRING CIRCUIT CARD ACCESSORIES

- A. The firing circuit card and its accessories shall consist of all the circuitry required to drive the SCR bridge. SCR firing shall be digital block gate. The firing circuit board shall be universal for the entire HP range of the starter.
 - 1. Synchronizing transformers shall furnish 18VA; 20VA from a 480V primary.
 - 2. All integrated circuits shall be mounted on sockets, not direct soldered.

2.04 CIRCUIT BREAKER

- A. The starters shall be combination type, incorporating a circuit breaker to provide short circuit motor protection with breaker disconnection of line voltage. A mechanical disconnect shall provide means of disconnecting the starter from the 480 volt source. The breaker shall be sized in accordance with guidelines of the manufacturer and the National Electric Code. The breaker shall be capable of being locked in the "OFF" position.

2.05 METERS

- A. Furnish a digital power meter to display electrical parameters including volts, amps, watts, etc. Required potential and current transformers shall be an integral part of the starters.

2.06 PROTECTION

- A. The starter shall include transient voltage protection consisting of a DV/DT R.C. network per phase. Undervoltage protection shall provide pick-up at 80% system voltage and dropout of 60%. The starter shall provide motor protection with an integral 3 pole overload relay.

- B. In order to facilitate ease of troubleshooting and monitoring, the starter shall include Diagnostic Light Emitting Diodes (LEDs). The following shall be monitored.
 - 1. Power (DC Control Voltage)
 - 2. Phase Correct
 - 3. Relay On
 - 4. SCR Gates
 - 5. Shorted SCR Indication
- C. The open loop voltage control shall have starting torque adjustment between 0 and 100%. Ramp time to full voltage shall be adjustable for a range of 0.5 to 60 seconds.

PART 3 - EXECUTION

3.01 PRODUCT ACCEPTABILITY

- A. Products that are specified by manufacturer, trade name or catalog number establish a standard of quality. Substitution of equal manufacturers will be subject to favorable review by the City Engineer.

3.02 PRODUCT AVAILABILITY AND ACCESSIBILITY

- A. The solid state motor starters shall have the manufacturer's standard warranty of one year. The supplier shall maintain an adequate replacement stock of all integral parts to include contactors, meters, selector switches, etc. The suppliers' service representative shall be located within a 50-mile radius of the project site and shall have been an authorized service representative for not less than three years.

3.04 MANUALS

- A. Operations and maintenance manual containing schematics, parts locations, part numbers and circuit narratives will be provided in accordance with Appendix 11 of the Service Conditions.

3.04 START-UP AND TESTING

- A. Start-up and testing shall be provided in conjunction with the variable frequency drives.

3.05 TRAINING – NOT USED

3.06. WARRANTY

- A. Starters furnished herein shall include a three (3) year manufacturer's warranty (from date put in service) on all solid state power sections and P.C. solid state control cards with one (1) year manufacturer's warranty (from date put in service) on other equipment of each system.

3.07. SPARE PARTS

- A. A complete set of Spare Parts shall be provided at no extra cost to the City. Spare parts shall include, but not be limited to:

1. One each of each type of Printed Circuit Board
2. One of each type and size of control fuse
3. Three of each type and size of power fuse
4. One complete spare Power Cell of each type and size used
5. One complete spare RTD monitoring device

END OF SECTION

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section outlines the design and electrical work for lighting equipment installations and wiring.

B. Related Design-Build Work Not Included in this Section:

1. Earthwork, Division 2.
2. Concrete, Division 3.
3. Painting, Division 9.

1.02 SUBMITTALS

A. Submit material lists, shop drawings, factory test reports and technical data to the extent required in this Section, Section 16010, and Appendix 5 of the Service Contract.

B. Shop Drawings. In addition to the information required to be included in Appendix 5 of the Service Contract and Section 16010, Shop Drawings shall include the following:

1. Manufacturer's catalog data sheets and/or drawings for all lighting equipment and poles. Catalog data and/or drawings shall clearly identify the equipment assembly, and locations for conduits.
2. Elevations showing the complete lighting fixture and the method of attaching the diffuser to the housing.
3. Types of lamps and ballasts for each lighting fixture. Ballast data shall include required starting and operating current.
4. Reflected ceiling plans and site plans showing fixture locations and spacing.

PART - PRODUCTS

2.01 GENERAL

A. Design and provide all the lighting fixtures, exit signs, wall brackets, post top units, lamps, site lights, poles, emergency lighting units and other fixtures and materials, including proper space, and complete the interior and exterior lighting installations as specified, as recommended by IES, and as required by OSHA for minimum indoor and outdoor lighting levels in work areas and walkways. All outdoor equipment shall be weatherproof and gasketed. The equipment shall have the manufacturer's corrosion resistant finish as indicated. The lighting equipment shall be

equipment shall be completely fabricated, assembled, checked and tested at the factory. Lighting equipment types shall be as shown on the drawings.

B. Interior Lighting Fixtures. Fluorescent lighting equipment shall be recessed, surface and pendant types as shown on the drawings or equal. The lighting fixtures shall be complete and include all the required components, lamps, wiring and supports.

C. Exterior Lighting Fixtures. High pressure sodium or metal halide units shall be provided for wall brackets, postop units, street lights and floodlights as shown on the drawings or equal. The lighting equipment shall be complete and include all the required components, lamps, poles, supports, hardware and wiring.

1. Lighting units shall have porcelain enameled formed sheet steel housings and cast aluminum housings as indicated. The paint shall be a polyester powder paint applied through a seven-stage process, and baked.

D. Fluorescent Ballasts. Ballasts for fluorescent fixtures shall be Class P. The ballasts shall be equipped with thermally actuated automatic re-closing protective devices. The overheat protective device shall be sensitive to current and winding temperatures, and shall prevent ballast case temperatures from exceeding 110 degrees centigrade. The ballasts shall be rapid start, 430 MA, high power factor, 60 hertz, and the circuit voltage as designed. In indicated cold areas (below 55°F), the fluorescent fixtures shall be equipped with cold weather ballasts and lamps. The ballasts shall be energy saving type with an input wattage of less than 80 when operating two F40 rapid start lamps.

E. Controls. Time switches, contactors, proximity detectors and photoelectric controls shall be provided as needed for automatic operation.

F. Branch Circuits. Wiring for the panelboard branch circuits shall be designed and provided as specified in Section 16050. The wiring, outlets and supports shall be complete.

G. Poles. Provide the metal poles, pole/top slipfitters, brackets, arms, anchor bases, base covers and hardware as indicated, specified and required.

1. Aluminum poles shall be fabricated from one piece of seamless tubing, and shall have mechanical properties not less than listed for AA6063/T6. The tapered pole shall have no longitudinal nor circumferential welds except at the lower end joining the pole to the base. The top end of the pole shall be equipped with a tenon for a slipfitter, adapter or bracket connection as required by the lighting units. Handhole with gasketed cover shall be provided near the base. Provide a ground terminal inside the handhole. Provide receptacles where indicated on the drawings.

2. Wiring base shall be cast metal of adequate strength and size, and provided with four holes and anchor bolts. The base enclosure shall have adequate space for equipment and conduits, and the openings shall provide proper access to the enclosure. The enclosure openings shall be equipped with gasketed and screw type covers. Wiring bases and hardware shall be suitable metal that can connect to aluminum poles and prevent electrolytic action.

H. Lamps. Lamps shall be provided for the lighting fixtures, floodlights, street lights and other lighting units as designed. The lamps shall be General Electric, Sylvania, or equal.

- I. Emergency lighting units shall consist of a battery, charger, monitor, lamps, pilot lights and switches. The equipment shall be automatic and solid state, and shall provide emergency lighting upon failure or interruption of the normal power. The battery shall be encased in a high impact, heat resistant, translucent plastic container with permanently sealed cover, and shall operate entirely unattended and require no additional water for at least 10 years under normal operating conditions. The unit shall include a pulse/type charger of sufficient capacity to restore the battery to full charge within 12 hours following a discharge of not more than 1.5 hours with the maximum allowable load connected. The charger shall also monitor the battery voltage and return to high/rate as required by the battery. The case shall be compartmented so that the charger and controls shall be separate from the battery. The cover shall be hinged at the front and equipped with a carrying handle. The emergency lighting units shall be Holophane HBK-O, Exide, Dual-Lite, or equal.

PART 3 - EXECUTION

3.01 GENERAL

A. Design and provide all the equipment installations and wiring installations, including connections as indicated, specified, and required. Assure proper fits for all equipment and materials.

B. Lighting Fixtures. Install all the interior and exterior lighting fixtures as designed.

1. Ballasts shall be provided for sodium and fluorescent.
2. Lamps shall be installed in the lighting fixtures.

C. Poles. Install metal poles anchored to concrete foundations for postop units, street lights and floodlights as designed.

1. Pole/Top Adapters shall be slipfitters, brackets and arms as designed.
2. Ballasts shall be installed in the lighting units or pole bases as required.

D. Floodlights, Street Lights, and Postop Units. Install all floodlights, street lights and postop units attached securely to the pole/top tenons, brackets and arms as designed.

1. Lamps shall be installed in floodlights, street lights, and postop units.
2. Adjust the floodlights so they provide a satisfactory light distribution.

- E. Emergency Lighting Units. Install the emergency lighting units securely attached to supports. Provide the wiring and connections to the 120 volts, 60 hertz, single phase branch circuits as designed.
 - F. Wiring. Provide complete wiring installations for the interior and exterior lighting units, switches, convenience outlets, automatic controls and grounding as designed and required.
 - G. Automatic Control. Install the photoelectric controls, time switches, proximity detectors and contactors as designed, and as required.
- 1. Adjust all the automatic controls so they operate satisfactorily.

END OF SECTION

SECTION 16620

STATIONARY STANDBY POWER GENERATOR SYSTEMS – DIESEL

PART I - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Providing and installing a complete and operable diesel engine driven standby power generator system, including all generators, devices and equipment specified, shown on the Drawings, and required for the service.
2. Providing and installing a weather proof, sound attenuating enclosure for all the generators.
3. Providing and installing a minimum 6 hour capacity day tank to connect into the bulk fuel storage system and place inside weather proof, sound attenuating enclosure.

B. Related Sections:

1. Section 16010 - General Electrical Requirements.
2. Section 16050 – Basic Material and Methods.
2. Section 16410 – Automatic Transfer Switch.

1.02 SUBMITTALS

A. Product Data:

1. Provide product data, manuals, technical literature, and installation instructions for all system components and accessories.
2. Provide a sequence of operation for all system components and accessories.
3. Provide ladder logic for all programmable logic controllers in the system.

B. Operations and Maintenance Manuals with as-built versions of all submittals required in this Section.

C. Shop Drawings:

1. Plan and elevation drawings with certified overall dimensions.
2. Internal wiring diagrams.
3. Interconnection wiring diagrams showing all external connections required; with field wiring terminals marked in a point-to-point manner.

D. Manufacturer's Certificate:

1. Furnish manufacturer's certificate for the standby generator system stating that:
2. The equipment has been installed under either the continuous or periodical supervision of the manufacturer's authorized representative.
3. It has been adjusted and initially operated in the presence of the manufacturer's authorized representative.

4. It is operating in accordance with the specified requirements and to the manufacturer's satisfaction.

E. Provide Service Manuals:

1. Supply information covering the operation, maintenance, and repair of all components within the standby generator system, include a list of all components and complete wiring diagrams.
2. Include complete manufacturers Service Manuals for all components (engine, alternator, etc.).
3. The list of components shall include a description, size, bulletin or catalog number and manufacturer's name, rating and any other pertinent information which shall properly identify the item.
4. Clearly identify items provided, cross out options not provided for this project.

F. Quality Control Submittals:

1. Tier 2 or 3 emissions compliance statement.
2. Test Reports:
 - a. Test reports.
 - b. Actual and expected test results for factory and field testing.
3. Certificates:
 - a. Manufacturers Certificate of Installation.
4. Manufacturer's Instructions:
 - b. Installation instructions.
 - c. Start-up and operation instructions.
5. Manufacturer's Field Reports.
6. Indication of the nearest field service office staffed with factory trained technicians. Provide service organization data and manpower. Indicate typical response time for emergency calls. Provide typical scenario for an emergency service call.

G. Contract Closeout Submittals:

1. Project Record Documents.
2. Operating and Maintenance Data.
3. Warranty: Manufacturer's published warranty documents.

1.03 QUALITY ASSURANCES

A. Equipment shall be new, factory assembled and tested, and delivered ready for installation.

B. Qualifications:

1. The system supplier shall be the manufacturer's authorized distributor, who shall provide initial start-up services, conduct field acceptance testing, and perform warranty service.
2. The supplier shall have 24-hour service availability and factory-trained service technicians authorized to perform warranty service on all system components.
3. All components shall be new and of current production of a national firm which manufactures and assembles the generator set as a complete, tested, and coordinated system.

4. The generator set manufacturer shall warrant all equipment provided under this section, whether or not is manufactured by the generator set manufacturer, so that there is one source for warranty and product service.
 5. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.
- C. The generator set manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.04 WARRANTY

- A. Provide a no deductible warranty for all products against defects in materials and workmanship for a five year or 1500 hour period from the date of substantial completion.
- B. Warranty shall cover all costs of covered repairs and parts, including travel expenses.

1.05 MAINTENANCE

- A. Extra Materials:
 1. Provide one spare filter, fuse, and belt of each type.
 2. Package in original factory cartons and deliver with generator system.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Cummins Power Systems, Inc.
- B. Caterpillar, Inc.
- C. Detroit Diesel

2.02 STANDBY POWER GENERATOR SYSTEM – GENERAL

- A. General:
 1. Provide a complete engine-generator set including all specified and required components and accessories.
 2. The engine-generator set supplier shall coordinate with and verify proper configuration of the automatic transfer switch settings.
 3. Regulatory Requirements:
 - a. The engine used for the generator system shall comply with U.S. EPA emission requirements for stationary applications.
 - b. Submit compliance statement.
- B. Ratings:
 1. The generator set shall operate at 1800 rpm and at a voltage of 480Volts AC, Three phase, Four-wire, 60 hertz.

2. The generator set shall be rated at kW necessary to start and run 100% connected load at 0.8 PF. Ratings shall be based on site conditions.
3. The generator set shall be capable of sustaining a minimum of 90-percent of rated no load voltage with the specified kVA load at near zero power factor applied to the generator set.

C. Performance:

1. Voltage regulation shall be plus or minus 0.5-percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5-percent.
2. Frequency regulation shall be isochronous from steady state no load to steady state rated load. Random frequency variation with any steady load from no load to full load shall not exceed plus or minus 0.5-percent.
3. The diesel engine-generator set shall be capable of single step load pick up of 100-percent nameplate kW and power factor, less applicable derating factors, with the engine-generator set at operating temperature.
4. The alternator shall produce a clean AC voltage waveform, with not more than 5-percent total harmonic distortion at full linear load, when measured from line to neutral, and with not more than 3-percent in any single harmonic.

D. Construction:

1. The engine-generator set shall be mounted on a heavy-duty steel base to maintain alignment between components.
2. The base shall incorporate a battery tray with hold-down clamps within the rails.
3. All switches, lamps, and meters in the control system shall be oil-tight and dust-tight, and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50-volts.
4. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location.

E. Connections:

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations.
2. Sufficient lug space shall be provided for use with cables of the number and size as shown on the Drawings.
3. Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.

2.03 ENGINE AND ENGINE EQUIPMENT

A. Engine:

1. The engine shall be diesel, 4 cycle, radiator and fan cooled.
2. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the alternator and all connected accessories.

B. Governor:

1. An electronic governor system shall provide automatic isochronous frequency regulation.

2. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions.
3. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set.
4. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.

C. Cooling System:

1. Skid-mounted radiator and cooling system rated for full load operation in 122 degrees F ambient as measured at the generator air inlet, based on 0.5 in H₂O external static head.
2. Radiator shall be sized based on a core temperature which is 20 degrees F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment.
3. Radiator shall be provided with a duct adapter flange.
4. The cooling system shall be filled with a 50/50-ethylene glycol/water mixture by the equipment manufacturer.
5. Rotating parts shall be guarded against accidental contact.

D. Engine Accessories:

1. Electric starter(s) capable of three complete cranking cycles without overheating.
2. Positive displacement, mechanical, full pressure, lubrication oil pump.
3. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.
4. Fuel System:
 - a. An engine driven, mechanical, positive displacement fuel pump.
 - b. Fuel filtering system, including:
 - i. Dual fuel/water separators.
 - ii. Dual fuel filters with replaceable spin-on canister elements.
 - iii. Piping and bypass valving to allow in-service changes during periods of extended operation.
 - c. Fuel cooler, suitable for operation of the generator set at full rated load in the ambient temperature specified shall be provided if required for operation due to the design of the engine and the installation.
 - d. Flexible supply and return fuel lines.
 - e. Provide an anti-siphon solenoid valve in the fuel line when shown on the Drawings or required by the installation. Interlock the solenoid with the day tank controls or the generator control panel as appropriate.
5. Replaceable dry element air cleaner with restriction indicator.
6. Engine mounted battery charging alternator, 40-ampere minimum, and solid-state voltage regulator.
7. Coolant heater:
 - a. Engine mounted, thermostatically controlled.
 - b. Heater voltage shall be as shown on the Drawings.
 - c. The coolant heater shall be UL499 listed and labeled.

- d. The coolant heater shall be installed on the engine with silicone hose connections.
- e. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12-inches.
- f. The coolant heater installation shall be specifically designed to provide proper venting of the system.
- g. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element.
- h. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.
- i. The coolant heater shall be provided with a 24 VDC thermostat, installed at the engine thermostat housing.
- j. An AC power connection box shall be provided for a single AC power connection to the coolant heater system.
- k. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100 degrees F in a 40 degrees F ambient, in compliance with NFPA110 requirements, or the temperature required for starting and load pickup requirements of this specification.

2.04 AC GENERATOR

- A. Actual alternator temperature rise measured by resistance method at full load shall not exceed 105 degrees Centigrade.
- B. The AC generator shall be; synchronous, four pole, 2/3 pitch, revolving field, drip-proof construction, single prelubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc.
- C. All insulation system components shall meet NEMA MG1 temperature limits for Class H insulation system.
- D. The generator shall be capable of delivering rated output (kVA) at rated frequency and power factor, at any voltage not more than 5-percent above or below rated voltage.
- E. A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance.
- F. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300-percent of rated current for not more than 10-seconds.
- G. The subtransient reactance of the alternator shall not exceed 12-percent, based on the standby rating of the generator set.

2.05 GENERATOR SET CONTROL SYSTEM

- A. General:
 - 1. The generator set shall be provided with a microprocessor-based control system that is designed to provide automatic starting, monitoring, and control functions for the generator set.

2. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control when specified.
3. The control panel shall be mounted on the generator set.
4. The control panel shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered.

B. Control Panel Operator Interface Equipment:

1. Mode selector switch:
 - a. When in the RUN position the generator set shall start, and accelerate to rated speed and voltage as directed by the operator.
 - b. In the OFF position the generator set shall immediately stop, bypassing all time delays.
 - c. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
2. EMERGENCY STOP selector switch:
 - a. Switch shall be red mushroom-head type maintained pushbutton.
 - b. Depressing the emergency stop switch shall cause the generator set to immediately shut down, and be locked out from automatic restarting.
3. RESET pushbutton:
 - a. The RESET pushbutton shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.
4. PANEL LAMP pushbutton:
 - a. Depressing the panel lamp pushbutton shall cause the entire panel to be lit.
 - b. The panel lamps shall automatically be switched off 10 minutes after the switch is depressed, or after the switch is depressed a second time.
5. AC Output Metering:
 - a. Analog metering:
 - i. Voltmeter and ammeter shall display all three phases.
 - ii. Ammeter and KW meter scales shall be color coded as follows: readings from 0 to 90-percent of generator set standby rating shall display as green; readings from 90 to 100-percent of standby rating shall display as amber; and, readings in excess of 100-percent shall display as red.
 - b. Digital metering:
 - i. Indicate generator RMS voltage and current, frequency, output current, output kW, kW-hours, and power factor.
 - ii. Generator output voltage shall be available in line-to-line and line-to-neutral voltages, and shall display all three phase voltages (line-to-neutral or line-to-line) simultaneously.
6. The control system shall incorporate a data logging and display provision to allow logging of the last 10 warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

C. Alarm and Status Display:

1. The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing warning and shutdown conditions.
2. The lamps shall be high intensity LED type.

3. The lamp condition shall be clearly apparent under bright room lighting conditions.
4. The control panel shall indicate the following alarm and shutdown conditions on an alphanumeric digital display panel:
 - a. Low oil pressure (alarm and shutdown).
 - b. Oil pressure sender failure (alarm).
 - c. Low coolant temperature (alarm).
 - d. High coolant temperature (alarm and shutdown).
 - e. Engine temperature sender failure (alarm).
 - f. Low coolant level (alarm or shutdown, selectable).
 - g. Fail to crank (shutdown).
 - h. Fail to start/over crank (shutdown).
 - i. Over speed (shutdown).
 - j. Low DC voltage (alarm).
 - k. High DC voltage (alarm).
 - l. Weak battery (alarm).
 - m. Low fuel day tank (alarm).
 - n. High AC voltage (shutdown).
 - o. Low AC voltage (shutdown).
 - p. Under frequency (shutdown).
 - q. Over current (warning and shutdown).
 - r. Short circuit (shutdown).
 - s. Ground fault (alarm).
 - t. Over load (alarm).
 - u. Emergency stop (shutdown).
5. The control panel shall display the following engine related parameters on the alphanumeric digital display panel:
 - a. Engine oil pressure.
 - b. Engine coolant temperature.
 - c. Engine oil temperature.
 - d. Engine speed.
 - e. Number of hours of operation.
 - f. Number of start attempts.
 - g. Battery voltage.

D. Engine Control Functions:

1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time, and number of cycles. Initial settings shall be for 3 cranking periods of 15-seconds each, with 15-second rest period between cranking periods.
2. The control system shall include an idle mode control, which allows the engine to run in idle in the RUN position only. In this mode, the alternator excitation system shall be disabled.
3. The control system shall include an engine governor control, which functions to provide steady state frequency regulation. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the

unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

4. The control system shall include time delay start (adjustable 0-300 seconds) and time delay stop (adjustable 0-600 seconds).
5. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed sender or wiring components, and an actual failure conditions.

E. Alternator Control Functions:

1. Voltage Regulation:

- a. Provide an automatic digital voltage regulation system that is matched and prototype tested by the engine manufacturer with the governing system provided.
- b. Immune from misoperation due to load-induced voltage waveform distortion and provide a pulse width modulated output to the alternator exciter.
- c. Equipped with three-phase RMS sensing and shall control buildup of AC generator voltage to provide a linear rise and limit overshoot.
- d. Include a torque-matching characteristic, which shall reduce output voltage in proportion to frequency below a threshold of 58 to 59 Hz.
- e. The voltage regulator shall include adjustments for gain, damping, and frequency roll-off.
- f. Adjustments shall be broad range, and made via digital raise-lower switches, with an alphanumeric LED readout to indicate setting level.

2. Output Current:

- a. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (over current warning) when load current exceeds 110-percent of the rated current of the generator set on any phase for more than 60-seconds.
- b. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (over current shutdown).
- c. The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

3. Short Circuit Protection:

- a. Controls shall be provided to individually monitor all three phases of the output current for short circuit conditions.
- b. The control/protection system shall monitor the current level and voltage.
- c. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the alternator (short circuit shutdown).
- d. The protective functions provided shall be in compliance to the requirements of NFPA70 article 445.

4. Load Controls:

- a. Controls shall be provided to monitor the kW load on the generator set and initiate an alarm condition (over load) when total load on the generator set exceeds the generator set rating for in excess of 5-seconds.
- b. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.

5. Output Voltage:

- a. Provide an AC over/under voltage monitoring system that responds only to true RMS voltage conditions.
- b. The system shall initiate shutdown of the generator set when alternator output voltage exceeds 110-percent of the operator-set voltage level for more than 10-seconds, or with no intentional delay when voltage exceeds 130-percent.
- c. Under voltage shutdown shall occur when the output voltage of the alternator is less than 85-percent for more than 10-seconds.

F. Starting Battery Monitoring:

1. Provide a battery monitoring system which initiates alarms when the DC control and starting voltage is less than 25 VDC or more than 32 VDC.
2. During engine cranking (starter engaged), the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 volts for more than two seconds a weak battery alarm shall be initiated.

G. Interfaces for remote monitoring:

1. All control and interconnection points from the generator set to remote components shall be brought to a separate connection box.
2. No field connections shall be made in the control enclosure or in the AC power output enclosure.
3. Provide the following signals for remote monitoring:
 - a. Generator Trouble Alarm: dry common alarm contacts rated 5-amps 120 VAC to indicate existence of any alarm or shutdown condition on the generator set.
 - b. Generator Ready: dry contacts rated 5-amps 120 VAC to indicate generator set is ready to load. The contacts shall operate when voltage and frequency are greater than 90-percent of rated condition.
 - c. Generator Run: dry contacts rated 5-amp 120 VAC to indicate the generator set is running.
 - d. Low Fuel Level: dry alarm contacts rated 5-amps 120 VAC to indicate a low fuel level. Required only when a sub-base fuel storage tank is provided.
 - e. Fuel Tank Leak Detection: dry alarm contacts rated 5-amps 120 VAC to indicate a low fuel level. Required only when a sub-base fuel storage tank is provided.
 - f. Weak Battery: dry alarm contacts rated 5-amps 120 VAC to indicate a weak battery condition.
 - g. Damper Control: auxiliary RUN relays, form C contacts. Contacts rating shall be suitable for de-energizing electric damper actuator(s) on normally open air intake damper(s) (quantity as required by the damper size). Minimum 10-amps 120 VAC.
 - h. A fused 10-amp switched 24DC power supply circuit shall be provided for customer use. DC power shall be available from this circuit whenever the generator set is running.
 - i. A fused 20-amp 24 VDC power supply circuit shall be provided for customer use. DC power shall be available from this circuit at all times from the engine starting/control batteries.

H. Sequence of Operation

1. A set of dry contacts shall be connected to the control system and shall initiate a generator start.
2. The generator set shall complete a time delay start period as programmed into the control system.
3. The generator set control system shall initiate the starting sequence for the generator set. The starting sequence shall include the following functions:
 - a. The control system shall verify that the engine is rotating when the starter is signaled to operate.
 - b. If the engine does not rotate after two attempts, the control system shall shut down and lock out the generator set, and indicate fail to crank shutdown.
 - c. The engine shall fire and accelerate as quickly as practical to starter disconnect speed.
 - d. If the engine does not start, it shall repeat the cycle cranking process. If the engine has not started by the completion of the cycle cranking sequence, it shall be shut down and locked out, and the control system shall indicate fail to start.
 - e. The engine shall accelerate to rated speed and the alternator to rated voltage. Excitation shall be disabled until the engine has exceeded programmed idle speed, and regulated to prevent over voltage conditions and oscillation as the engine accelerates and the alternator builds to rated voltage.
4. On reaching rated speed and voltage, the generator set shall operate as dictated by the control system in isochronous, synchronize, load share, load demand, or load govern state.
5. When the start signal has been removed from the generator set, it shall complete a time delay stop sequence. The duration of the time delay stop period shall be adjustable by the operator.
6. On completion of the time delay stop period, the generator set control system shall switch off the excitation system and shall shut down.
7. Any start signal received after the time stop sequence has begun shall immediately terminate the stopping sequence and return the generator set to isochronous operation.

2.06 GENERATOR SET ACCESSORIES

A. Circuit breakers:

1. Provide engine-generator set mounted and wired circuit breakers for the following:
 - a. Main type circuit breaker.
 - b. Load bank circuit breaker:
 - i. Provide lugs to facilitate a convenient method of connection to an external load bank.
 - ii. Lugs shall be available in a dedicated enclosure.
 - iii. Lugs shall be accessible though a weatherproof door when generator includes an outdoor weather protective enclosure.
2. UL listed, thermal-magnetic type.
3. Ground fault protected.
4. Both breakers sized for full generator load. Sizing by manufacturer.

B. Starting and Control Batteries:

1. Calcium/lead antimony type.
2. 24 volt DC, quantity and size as required by the engine-generator set manufacturer.
3. Provide battery cables and connectors.
4. With support trays and marine type acid spill proof box(s).

C. Exhaust and Silencer System:

1. Exhaust muffler(s) and exhaust pipe(s) shall be provided for each engine.
2. Exhaust system pipe size shall be as required by the engine-generator set manufacturer for the installation as shown on the Drawings. General routing shall be as shown on the drawings.
3. Horizontal discharge exhausts shall include bird screens and vertical discharge exhausts shall include rain hoods.
4. Silencers shall be of the Critical Muffler type and noise levels shall be suitable for residential areas.
5. Provide flexible bellows between the engine and exhaust system to isolate vibrations and allow for expansion and contraction.
6. All exhaust and silencer system components shall be fabricated from aluminized steel or 304 stainless steel.
7. Exhaust system shall be installed according to the generator set manufacturers recommendations and applicable codes and standards.

D. Battery Charger:

1. Provide a UL listed/CSA certified 10 amp voltage regulated battery charger for each engine-generator set.
2. The charger shall be wall mounted.
3. Input AC voltage shall be 120 VAC and DC output voltage shall be as required.
4. Chargers shall be equipped with float, taper and equalize charge settings.
5. Charger shall include:
 - a. Analog DC voltmeter and ammeter.
 - b. 12 hour equalize charge timer.
 - c. AC and DC fuses.
 - d. Power ON light.
 - e. Loss of AC power light.
 - f. Low battery voltage light.
 - g. High battery voltage light.
6. Provide individual dry contacts rated at 4-amps 120 VAC, 30VDC for remote indication of:
 - a. Loss of AC power.
 - b. Low battery voltage.
 - c. High battery voltage.

2.07 SOURCE QUALITY CONTROL

A. Factory Tests:

1. Equipment shall be tested at the factory for function and performance.
2. Provide two weeks' notice for testing. Testing may be witnessed by City and or City Engineer.
3. Tests on the equipment shall be performed at rated load and rated PF.
4. Tests shall include:
 - a. Operation at full load.
 - b. Rated power at 0.8 power factor.
 - c. Voltage regulation.
 - d. Transient and steady-state governing.
 - e. Single step load pickup.
 - f. Function of alarms and safety shutdowns.
5. Submit actual and expected test results.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with submittals, Drawings, manufacturer's instructions, and instructions included in the listing or labeling of UL listed products.
- B. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction.
- C. Fasten to structural concrete accordance with manufacturer's instructions and seismic requirements of the site.
- D. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing.
- F. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

3.02 FIELD QUALITY CONTROL

A. Tests:

1. Equipment shall be field tested for function and performance.
2. Provide two weeks notice for testing. Testing may be witnessed by City and or City Engineer.
3. Tests shall include:
 - a. Operation at maximum equipment load for 4-hours.
 - b. Voltage regulation.
 - c. Transient and steady-state governing.

- d. Single step load pickup.
 - e. Function of alarms and safety shutdowns.
 - f. A cold start test.
 - g. Power failure test including all system components (automatic transfer switch, engine-generator, etc.).
 - 4. Submit actual and expected test results.
 - 5. Make corrections and retest if actual results are not as expected as determined by City Engineer.
- B. Manufacturer's Field Services:
- 1. Include in contract price the cost of furnishing competent and experienced engineers or superintendents who shall represent the manufacturer and perform the following:
 - a. Assist the Company as required during installation.
 - b. Initially start equipment.
 - c. Adjust and test the equipment in conformity with the contract documents and the requirements of the manufacturer.
 - d. Provide training.
 - 2. Submit parameter configuration sheet documenting all as-built parameter settings.

END OF SECTION

SECTION 16670
LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.01 SCOPE

- A. This Section outlines the electrical work for lightning protection of structures that contain critical and sensitive electrical equipment.
- B. The Design-Build Work covered by this section of the specifications consists of furnishing all final design, labor, materials, and items of service required for the completion of a functional lightning protection system, in accordance with this section of the specifications and the applicable contract drawings.
- C. If it is necessary to depart from the contract drawings or submittal drawings covered below, submit details of such departures and reasons therefore to the Contract Administrator, with one copy to City Engineer for approval.
- D. The following specifications and standards of the latest issue form a part of this specification:
 - 1. Lightning Protection Institute (LPI) installation Code LPI175
 - 2. National Fire Protection Code NFPA 780

1.02 QUALITY ASSURANCE

- A. Install lightning protection system per the requirements of the Lightning Protection Institute and NFPA Standards for Lightning Protection Systems.
- B. Use only a state-of-the-art lightning protection system from an established, UL and LPI approved manufacturer of these systems.

1.03 SUBMITTALS

- A. Before starting Design-Build Work, submit for approval complete shop drawings showing the type, size, and locations for all equipment, grounds, and cable routings, etc in accordance with Appendix 5 of the Service Contract and Division 16 submittal requirements. Also certify that the equipment specified herein is installed by a master installer of the LPI or under the direct supervision of the same.
- B. Upon request, submit for approval samples and pertinent catalog data.

PART 2 - PRODUCTS

2.01 STANDARD

- A. In accordance with LPI requirements, equipment used in this installation will be factory-inspected, approved, and properly labeled.
- B. Use only equipment that is new, the product of a single manufacturer as outlined above, and of a design and construction suitable for application where needed, in accordance with accepted industry standards and LPI and NFPA Code requirements.

2.02 EQUIPMENT

- A. Use only materials be of the size, weight, and construction suitable for application where needed, in accordance with LPI and NFPA Code requirements for Class I structures, and per manufacturer recommendations.
- B. Use copper conductors, sized as shown on plans.
- C. Use copper air terminals that are solid, round copper bar of 1/2 inch minimum diameter, and that project 24 inches minimum above the object to be protected. Locate and space according to LPI and NFPA requirements. Aluminum air terminals, bases and cables may only be used for protection on galvanized steel surfaces as necessary.
- D. Use only cast bronze air terminal bases with bolt pressure cable connections, and mount securely with stainless steel screws or bolts. Crimp type connectors are not acceptable. Use a proper adhesive to secure bases that are on built-up tar and gravel roofs. Leave a minimum surface contact of 18.5 square inches.
- E. Use only cable fasteners that are electrolytically compatible with the conductor and mounting surface, and space according to LPI and NFPA Code requirements.
- F. Use only cast bronze bonding devices, cable splicers, and miscellaneous connectors with bolted pressure connections to cable. Cast or stamped crimp fittings are not acceptable.
- G. Use only brass, bronze, or stainless steel miscellaneous bolts, nuts, and screws.
- H. Unless otherwise shown, the Lightning Protection System shall have a minimum of two ground rods in ground wells spaced 10 feet apart for all ground termination. Ground rods shall be 3/4-inch diameter, copper, a minimum of 30-feet in depth. Each ground rod shall have less than 5 ohms. At least two down conductors, related ground rods and wells shall be provided for each building. Structures exceeding 250 feet of perimeter shall have one down conductor, equally spaced, for every 100-feet of perimeter or fraction thereof.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The installation shall be accomplished by an experienced installer who is a Certified Master Installer of the LPI or working under the direct supervision of an LPI manufacturer as listed above or his authorized LPI Certified Master Installer representative.
- B. Install all equipment in a neat, inconspicuous, and workmanlike manner. The system shall consist of a complete cable network on the roof involving all air terminals, splices, and bonds with cable downleads routed concealed either directly in the building construction or in conduit to ground.
- C. Enclose down conductors from grade level in a 1-inch PVC conduit in the inside of exterior walls, if practicable, and per LPI 175 and NFPA 780 requirements.
- D. Do not connect copper equipment to aluminum surfaces except by means of an LPI-approved bimetal transition fitting.

3.02 COORDINATION

- A. Design-Build Work with other trades to ensure a correct, neat, and unobtrusive installation.
- B. Ensure a sound bond to the system ground.

3.03 COMPLETION

- A. Secure and deliver the LPI System Certification to the Contract Administrator, with one copy to City Engineer upon completion of the installation.
- B. Also submit copies of as-built shop drawings with LPI Forms LPI-C1-01, -02, and -03 to finalize the LPI Certified System Application.

END OF SECTION

SECTION 16709

TRANSIENT VOLTAGE SURGE SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. The requirements of this section must be coordinated with the Division 16 electrical requirements and the Division 13 instrumentation requirements.

1.02 SUMMARY

A. These specifications describe the electrical and mechanical requirements for a high energy transient voltage surge suppression system (abbreviated as TVSS in this specification) and the requirements for transient protection for all electrical and instrumentation equipment and devices that are provided under this Service Contract. The specified system shall provide effective high energy surge current diversion and be suitable for application in ANSI/IEEE C62.41 Category B & C environments as applicable, as tested by ANSI/IEEE C62.45.

B. The Company shall provide the surge protection devices specified herein for the power distribution and instrumentation equipment, and shall coordinate the connection and installation with the equipment being provided.

1.03 REFERENCE STANDARDS AND PUBLICATIONS

A. The specified system shall be designed, manufactured, tested, and installed in compliance with the latest edition of the following standards and publications:

1. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.1, C62.11, C62.41, C62.45 and C62.62)
2. Underwriters Laboratories (UL 1449, UL 1283, UL497A, B, & C)
3. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
4. National Electrical Manufacturer Association (NEMA LS1)
5. National Fire Protection Association (NFPA 20, 70, 75, and 78)
6. CSA/CUL, Canadian Standards Association

B. The system shall be UL listed as a complete system under UL 1449 Standard for Transient Voltage Surge Suppressors (TVSS) and the rating shall be permanently affixed to the TVSS.

1.04 ENVIRONMENTAL SPECIFICATIONS

A. Storage Temperature range shall be -40°C to 85°C

B. Operating Humidity: 5% to 95% Non-Condensing

1.05 DOCUMENTATION

A. Submittals: The TVSS submittals, submitted in accordance with Appendix 5 of the Service Contract, shall include but shall not be limited to the following data:

1. Drawings: Electrical and mechanical drawings shall be provided by the manufacturer, which show unit dimensions, weights, component and connection locations, mounting provisions, connection details, and wiring diagram.
2. Documentation of specified TVSS Device's UL 1449 single pulse surge current capacity rating, repetitive surge current capacity and suppression (clamping) voltage ratings shall be included as required product data submittal information.
3. Spare Parts: A list of recommended spare parts shall be supplied at the customer's request.
4. Test Data: Submit independent test data showing compliance with manufacturers product ratings. Submit the test results that establish the products UL 1449 ratings. Include the individual factory quality assurance test results in the operation and maintenance manual.
5. Warranty information shall be provided for each model TVSS.
6. The Company shall furnish and submit to the Contract Administrator with copy to City Engineer for approval, an installation, operation and maintenance manual with installation, start-up, maintenance, and operating instructions for the specified system. The manual shall include items 1 through 5 above.
7. Identify location of transient protection devices in the submittals of other electrical equipment.

1.06 WARRANTY

A. The manufacturer shall provide a full five year warranty from the date of shipment against any part failure when installed in compliance with manufacturer's written instructions, UL listing requirements, and any applicable national or local electrical codes.

1.07 QUALITY ASSURANCE

A. The specified system shall be thoroughly factory-tested before shipment. Testing of each system shall include but not be limited to quality control checks, "hi-pot" tests at two times rated voltage plus 1000 volts per UL requirements, IEEE C62.62 Category B surge tests, UL ground leakage test, and operational and calibration tests.

1.08 MANUFACTURER QUALIFICATIONS

- A. The TVSS shall be products of the manufacturers named in Part 2 of this specification.
- B. Manufacturers requesting approval must meet the written specification and demonstrate

equivalence to products named in this specification. Submittals shall include independent test data for each product submitted.

- C. Repair: The TVSS manufacturer shall offer factory repair service and/or replacement parts for all units.

PART 2 - PRODUCTS

2.01 TRANSIENT PROTECTION FOR POWER DISTRIBUTION EQUIPMENT

- A. Suppressors shall be listed in accordance with UL 1449, Surge Protective Devices, and UL 1283, Electromagnetic Interference Filters.
- B. Suppressors shall be independently tested with category C3 high exposure wave form (20kV - 1.2/50 microsecond, 10kA - 8/20 microsecond) per ANSI/IEEE C62.41 - 1991.
- C. Visual indication of proper suppressor connection and operation shall be provided on the front of the enclosure.
- D. Suppressor shall incorporate bus bars for the surge current path. PC board trace, small round wiring or plug-in connections are not acceptable. Surge current diversion modules shall use bolted connections to the bus bars for reliable low impedance connections.
- E. Pulse life test: Capable of protecting against and guaranteed to survive 1,000 ANSI/IEEE C62.41 Category B3 transients without failure or degradation of UL 1449 clamp voltage by more than 10%.
- F. Suppressors shall have a warranty guarantee for a period of five years, incorporating unlimited replacements of suppressor modules if they are destroyed by transients during the warranty period.
- H. The system shall be connected in parallel with the protected system; no series connected elements shall be used.
- J. Suppressors shall meet or exceed the following criteria:
 - 1. Service Entrance/Main Switchgear Panel Protectors:
 - a. Single Impulse Surge Current Rating: Minimum of 600,000 amps per phase and 300,000 amps per mode surge current handling capability.
 - b. Independent Modes of Protection: L-N, L-G, N-G, L-L.
 - c. Minimum Repetitive surge current capacity: 15,000 impulses in every mode utilizing a 1.2 x 50 usec, 20 KV open circuit voltage, 8 x 20 usec, 10KA short circuit current Category C3 bi-wave at one minute intervals without suffering either performance degradation or more than 10% deviation of clamping voltage at the specified surge current.
 - d. Basis of Design, Current Technology model "SEL300"
 - 2. Distribution Panel/Sub-Panels or MCC's Rated Over 300 Amps
 - a. Single Impulse Surge Current Rating: Minimum of 300,000 amps per phase and 150,000 amps per mode surge current handling capability.
 - b. Independent modes of protection: L-N, L-G, N-G, L-L.
 - c. Minimum Repetitive surge current capacity: 5,500 impulses in every mode

utilizing a 1.2 x 50 usec, 20 KV open circuit voltage, 8 x 20 usec, 10KA short circuit current Category C3 bi-wave at one minute intervals without suffering either performance degradation or more than 10% deviation of clamping voltage at the specified surge current.

d. Basis of design, Current Technology model “TG150”

3. Distribution Panel/Sub-Panel or Lighting Panelboards Rated ≤ 300 Amps

a. Single Impulse Surge Current Rating: Minimum of 120,000 amps per phase and 60,000 amps per mode surge current handling capability.

b. Independent modes of protection: L-N, L-G, N-G, L-L.

c. Minimum Repetitive surge current capacity: 3,500 impulses in every mode utilizing a 1.2 x 50 usec, 20 KV open circuit voltage, 8 x 20 usec, 10KA short circuit current Category C3 bi-wave at one minute intervals without suffering either performance degradation or more than 10% deviation of clamping voltage at the specified surge current.

d. Basis of design, Current Technology model “TG60”

2.02 TRANSIENT PROTECTION FOR INSTRUMENTS AND EQUIPMENT.

A. General:

1. Provide transient protection devices to protect field instruments and equipment from the effects of transient surges caused by lightning and other electrical sources. TVSS shall be provided for AC power source, signal, control, communication and data lines.
2. Provide protection for all field and panel mounted instruments and equipment that have portions of interconnecting wiring located outside of protected buildings.
3. Transient protection devices shall be suitable for ANSI/IEEE C62.41 category C locations.
4. Transient protection devices shall be integral to instruments and equipment, otherwise as described below.
5. Provide transient protection devices at instruments and equipment as follows:
 - a. On 120 VAC power connection.
 - b. On analog signal connection.
 - c. On discrete signal connection.
 - d. On digital communication signals.
 - e. On other types of electrical connections.
6. Coordinate transient protection devices with instrument and equipment manufacturer.
7. Connect and ground in accordance with transient protection device manufacturers instructions.
8. Transient protection devices installed within panels and located at field instruments (see Section 13321) shall be by the same manufacturer.
9. Installation: As per the appropriate standard details and as per manufacturer’s instructions.

B. Construction:

1. MOV based suppression products rated for use above 110 VAC shall incorporate a thermally sensitive device to remove the metal oxide varistor (MOV) from service should the event of severe overheating occur.
2. Transient protection devices shall be capable of being monitored by direct visual means.

3. Transient protection devices shall be easily removed to facilitate testing to ensure proper protection levels. Removal shall not disrupt operation of protected circuits.
4. The transient protection devices shall be used as the interface terminal blocks when applicable.
5. Transient protection devices shall be capable of discharging currents of 10 kA using an 8/20 micro-second waveform as defined by ANSI C62.41.
6. Transient protection devices shall provide cascade protection using gas-filled surge arrestors, MOV, and surge suppressing diodes, unless noted otherwise.
7. Provide fuses, breakers, and other protection devices as required by the transient protection devices.

C. Installation:

1. Assemble transient protection devices in enclosure and locate near protected field instrument or item of equipment.
2. Transient protection devices shall be installed as close as practical to the protected equipment, panel, or switchboards to minimize connecting wire lead lengths.
3. Transient protection devices shall be approved for use in classified hazardous areas when required by the installation. Otherwise locate transient protection device enclosure outside classified hazardous area. Locate so downstream wiring and equipment is located within protected building.
4. Enclosure:
 - a. NEMA 4X.
 - b. Type 316 stainless steel.
 - c. Door screw clamps.
 - d. Include sub-panel.
 - e. Size as required.
 - f. Hoffman CHNFSS.
5. Construction: In accordance with Section 13326.
6. Nipple encased transient protection devices may be used for devices requiring protection on only one pair of wires. Use only with compatible instrument or equipment housing.
7. Two-wire analog and discrete signal applications which may not have a continuous ground path from the transient protection device or enclosure to a proper ground system shall be provided with a separate #12 ground wire for this purpose.
8. As per manufactures instructions.

D. Transient protection devices for 120 VAC Power Connections.

1. Suppression: Through MOV's connected between line-neutral, line-ground, and neutral-ground.
2. Maximum current through base: 26 A.
3. Continuous operation on selected AC or DC voltages.
4. Maximum surge current: 10kA.
5. Clamping voltage: less than 300V
6. Response time: less than 25 ns.
7. Manufacturer and model number:
 - a. Appropriate models as manufactured by Phoenix Contact.
 - b. Appropriate models as manufactured by Atlantic Scientific Corporation.
 - c. or equal.

E. Transient protection devices for Analog Signal Connections.

1. Continuous operation on selected AC or DC voltages.
2. Maximum surge current: 10 kA.

3. Clamping voltage: less than 1.8 times V(max).
 4. Line-line response time: less than 1 ns.
 5. Line-ground response time: less than 100 ns.
 6. Maximum current through base: 2 A.
 7. Loop impedance: less than 100 mOhm (design based on this value).
 8. Manufacturer and model number:
 - a. Appropriate models as manufactured by Phoenix Contact.
 - b. Appropriate models as manufactured by Rosemount Inc.
 - c. Appropriate models as manufactured by Atlantic Scientific Corporation.
 - d. or equal
- F. Transient protection devices for Discrete Signal Connections.
1. Continuous operation on selected AC or DC voltages.
 2. Maximum surge current: 10 kA.
 3. Clamping voltage: less than 1.8 times V(max).
 4. Line-ground response time: less than 1 ns.
 5. Frequency response: to 100 kHz.
 6. Nominal current capacity: 2 A.
 7. Manufacturer and model number:
 - a. Appropriate models as manufactured by Phoenix Contact.
 - b. Appropriate models as manufactured by Rosemount Inc.
 - c. Appropriate models as manufactured by Atlantic Scientific Corporation.
 - d. Appropriate models as manufactured by Allen Bradley.
 - e. or equal.
- G. Transient protection devices for Digital Communications Signal Lines and telephone lines.
1. Compatible with the signal type.
 2. Mechanically matched to the cable type.
 3. Manufacturer and model number:
 - a. Appropriate models as manufactured by Phoenix Contact.
 - b. Appropriate models as manufactured by Transtector Systems.
 - c. Appropriate models as manufactured by Atlantic Scientific Corporation.
- H. Transient protection device tester:
1. Provide a portable hand-held battery operated tester.
 2. Tester shall verify clamping and breakdown voltages for transient protection devices.
 3. Provide case, batteries, and leads.
 4. Manufacturer and model number:
 - a. Appropriate models as manufactured by Phoenix Contact.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The installation shall follow the TVSS manufacturer's recommended installation practices and comply with all applicable codes.
- B. Coordinate the installation of the transient protection device with the installation of the equipment being protected. The transient protection device shall be installed as close as practical to or within the equipment being protected.
- C. Upon completion of installation, provide the services of a factory-certified local service

technician to perform start-up testing. Record test results and compare to factory testing to confirm proper operation of equipment. Submit test results with operation and maintenance manuals.

END OF SECTION

SECTION 16721

FIRE DETECTION AND ALARM SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

A. This Section of the specifications includes the design, furnishing, installation, and connection of the microprocessor controlled, reporting fire alarm equipment required to form complete coordinated systems ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panel, auxiliary control devices, and wiring as specified here. The fire alarm systems shall comply with requirements of NFPA Standard No. 72 for protected premises signaling systems except as modified and supplemented by this specification. The systems shall be electrically supervised and monitor the integrity of all conductors. The systems shall be designed, furnished, and installed by a licensed and authorized representative of the equipment manufacturer. The system is defined as all fire alarm components such as control panel, detectors, pull stations, strobes, etc., and required cable, conduit and wire.

1.02 SCOPE

A. Fire Alarm. A new microprocessor controlled fire detection system shall be designed and installed in accordance with the specifications and DRAWINGS. Basic Performance: Initiation device circuits shall be wired Class B (NFPA Style B). Indicating appliance circuits shall be wired Style Y (Class B). A single ground or open on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm. Alarm signals arriving at the main Fire Alarm Control Panel (FACP) shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded. When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur. The System Alarm indicator shall flash. A local piezo electric signal in the control panel shall sound and a corresponding indicator on the initiating zone(s) in alarm shall flash. Initiating and history storage equipment shall log the information associated with each new Fire Alarm Control Panel condition, along with time and date of occurrence. All automatic programs assigned to the alarm point shall be executed and the associated indicating devices and relays shall be activated. As each circuit or control relay is activated, its indicator shall be illuminated.

1.03 QUALITY ASSURANCE

A. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality.

1.04 SUBMITTALS

A. SUBMITTALS shall be submitted in accordance with Article 5 of the Service Contract, 01600 and Section 16010. Include manufacturers name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, riser, complete wiring point-to-point diagrams, and conduit layouts.

B. Shop drawings shall include complete installation drawings including component locations, conduit and wire runs.

1.05 MANUALS

A. Submit complete operating and maintenance manuals listing the manufacturer's name(s) including technical data sheets in accordance with Appendix 11 of the Service Contract. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

1.06 SOFTWARE MODIFICATIONS

A. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

1.07 CERTIFICATIONS

A. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer that the local installing contractor is an authorized factory distributor and indicate that the installation will be performed by a Florida State Licensed EF Fire Alarm Systems contractor. Include the contractor's EF license and licensees name with the submittal package.

1.08 GUARANTEE

A. All Design-Build Work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

1.09 APPLICABLE SPECIFICATIONS

A. The specifications and standards listed below form a part of this specification. The system shall fully comply with these standards.

1. National Fire Protection Association (NFPA) - USA:

No. 70-90	National Electrical Code (NEC)
No. 72-90	Protective Signaling Systems
No. 72E-90	Automatic Fire Detectors
No. 72G-89	Notification Appliances for Protective Signaling Systems
No. 72H-88	Testing Procedures for Signaling Systems
No. 101-91	Life Safety Code
2. Underwriters Laboratories, Inc. (UL) - USA:

No. 50	Cabinets and Boxes
No. 268	Smoke Detectors for Fire Protective Signaling Systems
No. 268A	Smoke Detectors for Duct Applications
No. 864	Control Units for Fire Protective Signaling Systems
No. 521	Heat Detectors for Fire Protective
No. 464	Audible Signaling Appliances
No. 38	Manually Actuated Signaling Boxes
No. 346	Waterflow Indicators for Fire Protective Signaling Systems
No. 1481	Power Supplies for Fire Protective Signaling Systems
No. 1971	Visual Indicating Appliances
3. Local and State Building Codes
4. All requirements of the Authority Having Jurisdiction (AHJ).
5. The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL	Underwriters Laboratories, Inc.
FM	Factory Mutual
ULC	Underwriters Laboratories Canada
6. In addition to fire listing by UL under Standard 864, the FACP shall have listing under Standard 1076, Proprietary Burglar Alarm Systems.
7. The system shall be listed by the national agencies as suitable for extinguishing release applications.

PART 2 - PRODUCTS

2.01 EQUIPMENT AND MATERIAL

A. All equipment, material and components shall be new, and the manufacturer's current model and shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. All equipment and components shall be installed in strict compliance with manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load. The fire alarm equipment shall be as manufactured by Notifier, FCI, or equal.

2.02 FIRE ALARM SYSTEMS

A. Fire Alarm Control Panels (FACP) shall be of the conventional microprocessor type and may be configured as a 4, 8, 12 or 16 zone system with up to 8 control points for a maximum capacity of 28 points and 12 output circuits and shall be fully field programmable and allow quick updates to meet future needs. An FACP shall be provided for each building, and each FACP shall notify or initiate an alarm in the Main Control Room upon any device activation. Key features include a walk test for a single person to test the system which includes zone change audible indication and zone trouble indication, march time temporal code or stead selectable per indicating circuit or control relay, alarm verification programmable per zone with automatic discrimination between smoke detectors and dry contact initiating devices, field programmable with multiple passwords and a special programming key to ensure the integrity of field program information, releasing service option with selectable time delays, abort circuits, presignal option with selectable time delays and manual evacuation control including a positive alarm sequence option, two stage alert/evacuation option, power limited initiating and indicating circuits, resound of subsequent alarms, troubles, or supervisory signals, with a distinct local audible indication, any initiating zones may be programmed for normal, waterflow or supervisory operation, map any output circuit to any input circuit in non-volatile program memory, enable/disable per circuit from the front panel switches, integral power supply/charger for 7.0 and 12 AH batteries, ground fault detection and battery supervision, silence inhibit timer, RS-485 serial port for high speed data communication with remote annunciators to permit remote Acknowledge, Signal Silence and System reset, computer generate labels easily inserted to provide identification of all circuits, non-volatile EEPROM memory to repeating all program information even with a total loss of power, optional auxiliary audible/visual power supply, trouble reminder option, program initiating zones to act as remote acknowledge, silence or reset, tornado warning option, PNIS zone coding option, 80 character remote LCD display, networking option to communicate with other FACPs, non-alarm option for lower priority inputs such as drills, auto silence option and extensive transient protection using MOVs and PTCs. Notifier System 500 with a CAB-500 cabinet or equal.

B. Manual Pull Station shall be of the dual action type, constructed of Lexan with clearly visible operating instructions and the word "FIRE" molded into the housing, shall operate with or without a fiber break tube, and be equipped with a special key to test and reset the station and when

when activated the activation will be clearly visible and cannot be reset without the key. The station shall be surface or semi-flush mounted with semi-flush mounting to a single or double gang electrical back box and shall not be mounted less than 42" or more than 48" above the finished floor from the center of the back box. It shall contain screw terminals to easily connect to the conventional alarm loop. Notifier NBG-10 or equal.

C. Photoelectric Smoke Detector shall provide two or four wire operation with the appropriate mounting base, incorporate an optical sensing chamber, be factory preset at 3.0 percent nominal sensitivity, operate at a nominal 24 VDC, contain built-in signal processing, provide superior signal to noise ratio, incorporate fully wax coated PC boards and RFI protection, operate over a two or four wire loop, contain visible LEDs that blink at the system polling rate and illuminate steady on alarm, provide a 360 degree LED viewing angle, contain an integral test switch operated by an external magnet, sealed against back pressure, plug in to a separate base, contain a removable cover and insect resistance screen for field cleaning, provide a remove LED output connection, be constructed of Lexan and contain a built-in tamper feature. Notifier 2451 or equal.

D. Smoke Detector Base shall accept either ionization or photoelectric plug-in detectors for two wire operation, be constructed of Lexan and shall mount to a standard single gang or two gang electrical back box. Notifier B401B or equal.

E. Smoke Detector Base shall accept either ionization or photoelectric plug-in detectors for four wire operation, and contain a relay with Form A and C contacts rated at 2.0 amps at a nominal 30 VDC, for auxiliary control of elevators or other ancillary devices, be constructed of Lexan and shall mount to a standard single gang or two gang electrical back box. Notifier B402B or equal.

F. End-of-Line Relay Module shall be used to provide supervision of 12 or 24 volt power loops and shall contain one Form C relay with a contact rating of 7 amperes at 29 VDC. The unit shall be encapsulated with wire leads which can be mounted in a single gang back box. Notifier A77-716.

G. Strobe Assembly shall be of electronic design with a visual output of 100 cd at 24 VDC and a current drain of 88 Ma. The strobe assembly shall be constructed of high impact plastic with a textured, red finish face plate, the strobe lens and cover assembly will be a clear polycarbonate material and the entire unit will mount to a 4" square back box a minimum of 2-1/8" deep. Notifier GXS-4HR or equal.

H. Horn/Strobe Assembly shall be of electronic design operating at 24 VDC with a peak sound output of 100 Db at 10' with a field selectable steady or pulsed tone. the strobe module shall have an output of 100 cd. The assembly shall have a total current draw of 105 Ma. The horn/strobe assembly shall be constructed of high impact plastic with a textured, red finish face plate, the strobe lens and cover assembly will be a clear polycarbonate material and the entire unit will mount to a 4" square back box a minimum of 2-1/8" deep. Notifier SHG-24H or equal.

I. Wire for conventional initiating, indicating, control and DC circuits shall be two conductor UL listed Type FPL for use in conduit or non-plenum applications shall be West Penn 970, 971, 972 and/or 973, as required, to meet required current carrying capacities as

recommended by the manufacturer. Plenum cable for use in open area application in compliance with applicable NFPA standards, UL listed FPLP type shall be West Penn 506970, 506973 and/or 506974 as required, to meet required current carrying capacities as recommended by the manufacturer.

J. Surge Protection shall be provided for the AC entry into the FACP and for every initiating, indicating, control and DC circuit being installed underground between buildings. Surge protection shall be installed at every location where fire alarm circuits enter or leave a building. The protection equipment shall be installed in a 16 gauge steel cabinet with a screw cover of adequate size to house all surge protection equipment terminal strips and cabling. The AC surge protection shall have a response time of 1 nanosecond, a clamping level of 130 VRMS, protection between ground, neutral and phase, automatic reset after each surge within ratings and a functions indicator light. Surge protection shall comply with the requirements of Section 16709.

K. Batteries shall be of the sealed Gel Cell type, completely maintenance free and shall have sufficient capacity to power the entire fire alarm system for not less than twenty-four hours in standby mode plus 5 minutes in alarm upon failure of AC power.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Installation shall be in accordance with the NEC, NFPA, state and local codes, and as recommended by the major equipment manufacturer. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed until all building areas are free of dust and dirt and will be installed just prior to the system programming and test period. All fire detection and alarm devices, control panels and remote annunciators shall be flush or semi-flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

3.02 TESTS

A. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

B. Before energizing the system, all cables and wires shall be checked for correct connections and tested for short circuits, ground faults, continuity and insulation. The AC power source shall be checked to verify that it is 120 VAC, 60 Hz, single phase connected to a dedicated 20 ampere circuit breaker which serves only the fire alarm equipment.

C. Activate each manual pull station, smoke detector, heat detector and any other initiating device to verify that the proper alarm is activated at the FACP and remote annunciator(s) and the alarm appears in the designated alarm zone.

D. Open each initiating circuit to determine that a trouble condition is activated at the FACP.

- E. Open and short each indicating circuit to determine that a trouble condition is activated at the FACP.
- F. Ground each initiating and indicating circuit conductor to verify that the FACP shows a ground fault trouble condition for that circuit.
- G. Check the presence and audibility of alarm and/or voice tones at all alarm notification devices.
- H. Check the entire installation, supervision and operation of all equipment in the system and verifying the proper mounting height of all manual pull stations and visual signaling appliances.
- I. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and processing of each signal at the FACP and the correct activation of all control points.
- J. When the system is equipped with optional features, the manufacturer's installation and operating manual shall be consulted to determine the proper testing procedures.

3.03 MAINTENANCE AGREEMENT

A. Complete maintenance and repair service for the fire alarm system shall be available from the authorized factory distributor of the manufacturer both during and after the guaranty period. An Inspection Agreement and a Guaranteed Maintenance Agreement quotation shall be prepared and presented to the Contract Administrator, with copy to the City Engineer prior to the final inspection of the system which shall contain the following information;

1. The Inspection Agreement shall provide for testing the fire alarm systems at the end of the one year guaranty period and annually thereafter in accordance with Florida State Statute 4A48 and applicable NFPA standards. The inspection shall include, but not be limited to, the cleaning and testing of each and every device within the fire alarm system including vacuuming of each smoke detector and include the sensitivity testing and recording of each smoke detector after the first year of operation and bi-annually thereafter. The testing of each device shall be recorded in an equipment test log showing the condition of the test for each item. Any items found to be malfunctioning or inoperative shall be noted on the log and shall be replaced at the time of inspection to leave the system in 100 percent operating condition in accordance with NFPA standards and manufacturers recommendations upon completion of the inspection. The inspection shall include the proper completion of all NFPA forms, a copy of which will be left on the premises and/or with the Contract Administrator, with copy to the City Engineer and a copy will be forwarded to the local authority having jurisdiction, if required. The initial Inspection Agreement quotation shall be signed by the City Engineer, a copy of which will be included with the "close out package" for use by the inspectors and AHJ at the final systems inspection and acceptance.

2. A Guaranteed Maintenance Agreement (GMA) shall also be presented to the Contract Administrator, with copy to the City Engineer which will include pricing for all tests and operations listed for the Inspection Agreement above but this price shall include the annual cost for

cost for performing all tests, inspections, service, replacement of defective equipment or components and repairs to the system at an annual, fixed flat rate price. This price quotation will also stipulate the hourly contract rate for performing emergency service after normal business hours which are 8:00 AM to 5:00 PM Monday through Friday when requested by the City Engineer. The GMA shall not cover service labor or replacement of system parts and components as a result of damage due to acts of God, neglect, malicious damage, theft or other reasons beyond the vendor or owners control. This agreement may be signed in lieu of the Inspection Agreement prior to final system testing and acceptance, a copy of which shall be included with the close out package.

3. Documentation to be included in the close out package which will be made available prior to final system testing and acceptance by the local Authority Having Jurisdiction (AHJ) and the City Engineer shall include but not be limited to complete system operating instructions, a zone chart of all fire alarm zones, copies of technical data sheets on all system components and sub systems, all necessary wiring diagrams to permit proper system service, final "Record Drawings" showing the routing of all conduits and location of all devices and equipment, a copy of the system test log, a copy of all necessary NFPA inspection forms properly completed, a copy of the signed Inspection Agreement or Guaranteed Maintenance Agreement and any other documentation deemed necessary by the Contract Administrator and the City Engineer or the AHJ to properly inspect and maintain the fire alarm system.

3.04 FINAL INSPECTION

A. At the final inspection the fire alarm contractor shall have all required documentation, as listed above, and equipment spares available for review and acceptance by the City's and the AHJ. A factory trained representative of the contractor shall perform a complete systems test in the presence of all parties to show that the system is installed and operating in accordance with the manufacturer's guidelines and NFPA standards.

3.05 INSTRUCTION – NOT USED

END OF SECTION

SECTION 16725
SECURITY SYSTEM

CUT SHEETS FOLLOW

M12D-Night Technical Specifications

Dual-Lens Day&Night IP Camera

Security-Vision-Systems



... the new face of IP video



M12D with SecureFlex wall mount

Highlights

- In/Outdoor camera (IP65) with wall mount and fully concealed cabling
- Dual image sensors (two lenses), color and IR-sensitive B/W
- Integrated microphone and speaker
- Bidirectional IP & ISDN telephony
- Audio transmission to the browser
- Definable exposure zones
- Integrated video motion detection
- NightVision with up to 1 sec. exp. time
- Digital zoom and panning
- Video/audio recording and playback
- Software DVR for Windows/Linux/OS X
- Alarm management with pre- & post-alarm images

Dual Camera System 2.5 Megapixels

- Fully digital color CMOS image sensor with 1280x960 pixels and backlight correction
- Fully digital B/W CMOS image sensor with 1280x960 pixels and eight times higher sensitivity than color sensor
- Two 8 mm standard wide-angle lenses: 5-element glass lens 1:2.0, 45° horiz.
- Optional: Tele lenses

Automatic Exposure Without Iris

- Auto exposure times from 0.1 msec. to 1 sec.
- Configurable min./max. shutter speeds
- Freely definable exposure windows
- Purely software-based control with exposure windows, white balance, automatic contrast, sharpness filter and backlight correction
- MOBOTIX TrueColor software
- Individual exp. control for each image sensor

Image Formats and Frame Rates

- Color 1280x960, 640x480, 320x240, 160x120
- Dual camera: 2560x960, 1280x480, 640x240
- Free image formats with zoom and panning (e.g. 1000x200 for skyline format)
- Image formats: JPEG, Motion JPEG, MxPEG, BMP
- Frame rate using MxPEG (320x240): 30 fps
- Frame rate using MxPEG (640x480): 30 fps

M12D: Megapixel IP Camera System With Integrated Recording

The M12D-Night has two integrated image sensors and two lenses. Depending on the illumination level, the camera automatically selects the color image sensor with daylight lens or the more light-sensitive B/W image sensor with IR lens to record the images.

The resolution of 1280 x 960 pixels is about twelve times as high as the CIF images from an analog camera. In VGA (640 x 480) and CIF (320 x 240) mode, the camera provides up to 4x zoom while creating minimal network load (MxPEG: approx. 1 Mbps, CIF 25 fps). Bidirectional audio, video motion detection and a passive IR sensor are also integrated. The Ethernet, ISDN and RS232 interfaces of the camera comply with current IT standards, including GSM/GPRS/UMTS (3G).

Digital zoom, panning, video motion detection, event-controlled frame rates and freely selectable image sections reduce the storage requirements of the M12 to a minimum. The integrated camera software features include alarm management with pre- and post-alarm images, FTP, e-mail, external ring buffer storage on Windows, Linux and Mac OS X computers as well as playback and MultiView functions for up to 40 cameras in the browser. Since the camera does not require additional heating (operating temp. -30 to +60°C, -20 to +140°F), power can be supplied via the network.

- Frame rate using MxPEG (1280 x 960): 10 fps
- Scheduled obscuring of image areas

Image Storage Included

- Internal image storage (up to 600 Mega, 2,500 VGA, 4,000 CIF images or 6 min. video)
- Event and time-controlled image storage
- Adj. number of pre- and post-alarm images
- Browser playback with event search features

Recording Included

- Integrated ring buffer recording by the camera on Windows or Linux file servers
- Event-controlled Snap Shot image recording with pre- and post-alarm images
- Event-controlled MxPEG recording (video and audio) with 2.4 Mbps at 640x480 pixels

Video Management Included

- Ring buffer with up to 1 million alarms on the PC/server (no software installation or FTP!!!)
- Adjustable ring buffer size and delete schedule
- Image management with time/date search
- Definable MultiView for up to 30 cameras
- Freely definable function buttons
- MxCC Windows client with Layout Editor

Event/Alarm Control Included

- Freely definable time functions/repeats
- Passive IR motion sensor, signal input
- Temperature, illumination, microphone volume
- Motion detection in definable video motion fields
- TCP/IP messages on IP ports (Ethernet and ISDN)

Alarm Signalling Included

- Signal output and audio messaging
- E-Mail and FTP via network or ISDN
- TCP/IP messages on IP ports (Ethernet and ISDN)
- Phone call (list & PIN code), with voice message

Audio SIP Telephony and VoIP

- Integrated microphone and speaker
- ISDN telephony (with PIN code)
- Voice-over-IP to/from Windows PC
- Custom voice messages easily recorded
- Video IP telephony using SIP standard
- Automatic phone call on event/alarm
- Remote-control of camera from any phone
- Lip-synchronous audio recording (MxPEG)

Software Everything Included

- No software installation required
- Live images and admin. using web browser
- Complete video management and recording software integrated in camera
- 4 simultaneous browser operating modes: HTML/JavaScript with M-JPEG, streaming (Java), ActiveX (MxPEG), PDA-optimized pages
- PDA interface with HTML-only pages (Pocket PC compatible)
- Website updates via FTP, also using ISDN
- Multiple cameras in one browser window
- Simultaneous ISDN dial-in/dial-out using PPP
- Freely definable user groups and access rights

Power Supply 3 Watts

- Power supply via data cable, fully concealed
- PoE IEEE 802.3af compliant
- 3W power consumption

Mechanics Maintenance-Free

- Fiber-reinforced housing with weather protection
- Integrated wall/ceiling mount with fully concealed cabling
- Weight (incl. SecureFlex wall mount): 850 g
- Dimensions (incl. SecureFlex wall mount): 130 x 240 x 175 mm (w x d x h)

Characteristics

- Hardware resolution:
Two 1280 x 960 CMOS, color and B/W
Free software format with zoom/pan
- Frame/data rates for MxPEG video streaming (50% JPEG):

30 F/s	CIF (320x240)	1,2 Mbps
30 F/s	VGA (640x480)	2,4 Mbps
10 F/s	Mega (1280x960)	2,5 Mbps
- Day lens sensitivity (8 mm/2.0)
1 Lux at 1/60 sec., 0.05 Lux at 1 sec.
- IR/Night lens sensitivity (8 mm/2.0)
0.1 Lux at 1/60 sec., 0.005 Lux at 1 sec.
- Audio codec
64 kBit ISDN and SIP (IP telephony)
- Temperature: -30° ... +60°C, IP 65

Technical information subject to change without notice

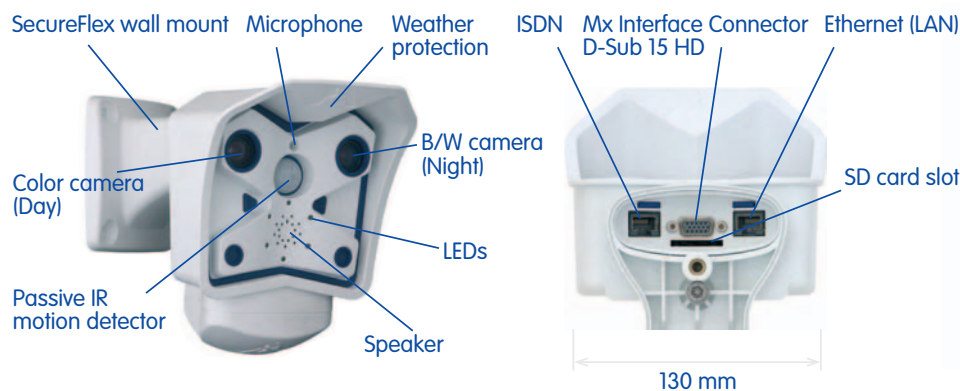
M12D-Night Technical Specifications

Dual-Lens Day&Night IP Camera

Security-Vision-Systems



... the new face of IP video



Mounting to ceiling

Outdoor wall mount with space for RJ45 wall outlet



L22 Super wide-angle 90°

L32 Wide-angle*

L43 Wide-angle

L65 Tele*

L135 Tele



*not available for M12

Overview M12 Standard Models (see price list for details)

- M12M-Web-D43: In/outdoor camera for mounting to ceiling or wall, MEGA (1280x960), L43 wide angle lens
- M12D-IT-Night-D43N43: In/outdoor **Day/Night** camera (VGA) with one color, one B/W sensor, L43 wide angle lenses
- M12D-Sec-D22D135: In/outdoor camera for mounting to ceiling or wall, MEGA (1280x960), L22 super wide angle and L135 tele lens
- M12D-Sec-DNight-D22N22: In/outdoor **Day/Night** camera (MEGA) with one color, one B/W sensor, L22 super wide angle lenses
- M12D-Sec-DNight-D43N43: In/outdoor **Day/Night** camera (MEGA) with one color, one B/W sensor, L43 wide angle lenses

Standard Delivery Includes

- M12D-Night camera
 - Camera with two camera modules
 - one color, one B/W image sensor and two lenses
 - automatic Day/Night switching
 - SecureFlex wall mount
 - Ethernet cable 50 cm
- SecureFlex wall mount
 - Wall mount made of 30% fiber-reinforced and shock-resistant PBT
 - Dowels and stainless steel screws

M12D-Night Technical Specifications

Dual-Lens Day&Night IP Camera

MX Interface Connector for Direct Connections

The MOBOTIX camera has **one switch input and one switch output** as well as **two signal inputs and two signal outputs** on the MX Interface Connector (D Sub 15 HD). You can use the camera's signal input/output pins, for example, to detect an opening door (using a Reed switch) or to switch on external device (e.g. a lamp).

The interface connector also has **Line In/Out pins for external audio devices**. You can use the Line In pin to have the camera transmit and record external audio signals (e.g. from an external microphone with pre-amplifier). On the other hand, the camera can use the Line Out pin to transmit sound to external devices (e.g. an audio amplifier). This in turn opens new possibilities as the camera can feed external loudspeakers (such as announcement systems on a train station) or it can use external and more sensitive microphones that can be placed farther away from the camera (e.g. when using a MOBOTIX camera as a video conferencing system and in access control scenarios).

Pin-out of MX Interface Connector D Sub 15 HD					
	PIN	Signal	Alternative	Description	Remarks
	5	GND		Ground for RS232, USB, Backup V-In	
Audio	4	Line-In +		Audio input , Line signal level $U_{RMS}=1V$	Galvanically isolated by transformer (DC decoupled)
	6	Line-In -			
	10	Line-Out +		Audio output , Line signal level $U_{RMS}=1V$	Galvanically isolated by transformer (DC decoupled)
	14	Line-Out -			
Signal	9	In 1		Signal input , active < 0,5V, inactive > +3V, max. voltage=24V	
	1	Out 1		Signal output , OpenCollector, active vs. GND, max. 24V/50mA, inactive 10kOhms vs. 3.3V	
USB	13	USB +5V		Power supply for USB devices 5V/100mA vs. GND	With backup power (12V) or PoE, 500mA also possible
	11	USB D+		USB master data signals , 0V to 3.3V	
	12	USB D-			
Serial interface	2	RxD	RxD-RS232	active = -3V to -12V, inactive = +3V to +12V	
			RxD-IO	Signal input , inactive: open or voltage > 3V, active : GND or voltage < 0V, max. $\pm 12V$	
	3	TxD	TxD-RS232	active = -3V to -12V, inactive = +3V to +12V	
			TxD-IO	Signal output , inactive: < 3V max. 3mA, active : > +3V max. 3mA, max. voltage $\pm 12V$	While the system reboots, the signal state is undefined
	7	RTS	RTS-RS232	active = +3V to +12V, inactive = -3V to -12V	
			RTS-IO	Signal output , inactive: < 3V max. 3mA, active : > +3V max. 3mA, max. voltage $\pm 12V$	While the system reboots, the signal state is undefined
	8	CTS	CTS-RS232	active = +3V to +12V, inactive = -3V to -12V	
			CTS-IO	Signal input , inactive: open or voltage > 3V, active : GND or voltage < 0V, max. $\pm 12V$	
	15	Backup V-In		Backup power 6V to 12V vs. GND, max. 1A	



M12D-Night Technical Specifications

Dual-Lens Day&Night IP Camera




Hard- and Software Differences of the MOBOTIX M10/M12

To make a long story short – nothing changes with the basic functionality or the looks of the camera. Users, who have worked with M10 models before will not have any problems adjusting to a MOBOTIX M12.

Switching to the three times faster Intel "Bulverde" PXA270 processor with 520 MHz frequency has boosted image processing considerably, providing for notably higher image rates (up to 30 fps in VGA, up to 10 fps in MEGA resolution). The new hardware also brings new features, such as SIP video (Internet telephony with video) and new possibilities for extending the hardware (SD card, CF slots, MX Interface Connector, USB master pins for MOBOTIX expansion modules, etc.).

The following table shows the most important differences in the hardware and software:

		MOBOTIX M10	MOBOTIX M12
Hardware Differences			
Housing color		Gray or White	White
Wall/ceiling mount		Ball joint, SecureFlex mount for Secure models	SecureFlex mount covers RJ45 wall outlets and conceals the cabling (all models)
Lens options		Wide-angle L43, Tele 135	Super Wide-Angle L22, wide-angle L43, Tele 135
Serial interface		D Sub 9	D Sub 15 HD
USB connector		--	USB master (for MX expansion modules)
SD card*		--	SD card for extra storage
CF slot**		--	CF slot for MOBOTIX expansion modules (wireless, storage, ...)
Line In/Out pins for external audio devices		--	External microphones/PA systems via D Sub 15 HD
Backup power supply		--	Backup power (6 to 12 V, max. 1 A) via D Sub 15 HD
ISDN power supply		Power supply via ISDN NT	Power supply via ISDN NT not possible, but can be injected into 8-wire cable (split cable required)
PoE power supply		MOBOTIX PoE products (MX-NPA + power supply / NPR-4/8/20)	MOBOTIX PoE products and standard PoE IEEE 802.3af
Software Differences			
Frame rate (fps)		25 CIF • 12 VGA • 4 MEGA	30 CIF • 30 VGA • 10 MEGA
SIP video		--	SIP video

* Available end of 2006

** Supported in future software versions; only installed at the factory!

PASSPOINT PLUS

**PASSPOINT**
PLUS

The PassPoint family of products has now been expanded with PassPoint PLUS, the enhanced version of the widely acclaimed PassPoint Express. Like PassPoint Express, PLUS continues to offer powerful simplicity in setup and maintenance, which provides major savings in materials and labor. PLUS is a full-featured access control system priced at the cost of systems with far fewer capabilities and features. This is truly an all in one package.

BENEFITS AND FEATURES

BADGING

- Custom Photo ID Badge design software and twain compatibility means there are no additional expensive software packages to buy
- Place card holder information or bar codes on ID badges
- Card holder's picture displays based on an event

FLOOR PLAN GRAPHICS

- Dynamic 3-D view with real-time maps provide visual status of the facility
- Controls system devices from the floor plan view
- No need to go through multiple screens to unlock a door
- Built-in Floor Plan Designer

REPORTING ENHANCEMENTS

- Scheduled reports do not require manual intervention which saves time and money
- Run a report from archived events to find out what events took place last month
- Reports available via internet for easy access

REAL-TIME ALARM MONITORING

- User-defined instructions reduce training time for system operators
- Event reports will show annotations, forcing guards to acknowledge an event
- Recognizing important events is easier by adding colors and sounds
- Event notification without system operator intervention via numeric/alphanumeric pager, email, or website posting

PASSPOINT DIRECT

- Provides updates and the latest system news via the internet
- Automatic notification from user defined web server

ADDITIONAL FEATURES

- Magnetic stripe (ABA Track 2) support allows you to retro-fit existing installations or generate a unique format for a new customer
- Batches of card holders can be modified quickly and easily, eliminating tedious, repetitive card holder data modification

PassPoint PLUS



DYNAMIC FLOOR PLAN GRAPHICS

- Dynamic 3-D view
- Control actions right from the floor plan
- Zoom-in to additional maps
- Built-in Floor Plan Designer

PHOTO-ID BADGING

- Custom badge designer
- Uses your active database in design mode
- Visual Verification Mode (Grant or deny access after a card is presented)
- Twain compatible



THE HEART OF THE SYSTEM

PassPoint PLUS is bundled in complete kits with everything needed for a two-door access system. The PTPLUSASK Access Starter Kit consists of:

MLB-MAIN LOGIC BOARD

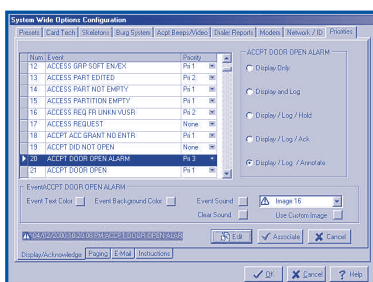
The MLB is the main controller of the access control system. It holds the system configuration information, card database, and event log. It includes a real time clock used to validate schedules and provide a time and date stamp for events. The MLB also provides two input zones and one form C relay output.

DCM-DOOR CONTROL MODULE

The DCM provides all of the inputs and outputs necessary to manage up to two doors of access control. Two supervised form C relays, two trigger outputs, and four supervised zone inputs (for managing door status and egress) are supplied on-board.

POWER SUPPLY

The power supply produces a nominal 12 VDC at 1.8 ampere when connected to the supplied 18 VAC transformer. It has sufficient power to run the MLB, DCM, two card readers, and two door locks (rated 12 VDC at < 450 mA each).



REAL-TIME ALARM MONITORING

- See Alarms and Events as they happen!
- Route Alarms and Events through
 - Alpha or Numeric Pager
 - Email
 - Internet Website
 - Add sound or colored events
 - Annotate each event
 - Leave detailed instructions upon event

SIMPLE LOW COST SYSTEM EXPANSION

PassPoint delivers the absolute lowest cost for expansion. You save hundreds of dollars per door on wiring, labor and equipment.

DEK-DOOR EXPANSION KIT

The DEK includes the materials you need to expand your existing PassPoint Access Control System. Each single kit provides the basic equipment for an additional one or two-door installation. It contains a PassPoint DCM and power supply combination that is pre-mounted in a metal-backed box and an 18 VAC transformer is also included.

PassPOINT EXPRESS

PASSPOINT EXPRESS

PassPoint Express is the powerful base that is the foundation for PassPoint PLUS. Express is designed to provide you with the lowest cost and simplest access control system that will expand easily for the growing customer.

ECHELON LONWORKS®

- For quick and easy service near access points (doors) LonWorks allows modules to be conveniently distributed throughout the facility
- LonWorks requires inexpensive, polarity insensitive, unshielded twisted pair wiring between panels
- Using Bus Topology
 - Up to 4000' using 18 AWG/2 conductor wiring (recommended) or
 - Up to 8000' using 16 AWG/2 conductor wiring
- Using Free Topology (star, loop, or loop/bus combination)
 - Up to 1500' using 20-22 AWG/2 conductor wiring
- New modules are enrolled using a plug and play type of operation (no dip switches)
- Major reduction of installation costs for wire, labor, equipment and programming

MAINTENANCE AND REPORTING

- Configuration Wizards walk the user through the system, simplifying otherwise complex tasks
- Save on travel costs and generate revenue with remote service and reporting
- Save time by using the systems many pre-configured reports (hourly, daily, weekly)
- In the event of power loss all configurations and transaction data are maintained, because flash memory is used
- Multiple reader technologies and formats, make PassPoint ideal for retro-fit installations

POWER SUPPLY

- Power supply in the unit has sufficient power for readers, logic boards and locks
- Power supply monitors the conditions of the battery, in the event of AC power loss or low-battery a report is made to the system
- No need for extra power supplies on a new installation



WIZARDS

- Easy to use
- Quickly setup system
 - Panel Configuration
 - Software Configuration
 - Card Holders
 - Hardware Enrollment

PassPoint PLUS

PC REQUIREMENTS

Operating System –

Windows 95, 98, or NT 4.0

IBM Compatible PC – Intel® Pentium Processor® II (200 mHz)

Disk space – 80 MB Hard drive space available with 32 MB of RAM

Monitor – SVGA video display 800 x 600 resolution (256 colors)

Printer – Configured printer for reporting

Mouse

PANEL SPECIFICATIONS

SIZE 14.5" H x 12.5" W x 3" D

POWER 18 VAC 50 VA or
12 VDC 1.8 amps

TEMPERATURE 35°F to 110°F (2°C to 43°C)
Humidity 90% max.
non condensing

ORDERING INFORMATION

- PTPLUSASK** PLUS Access Starter Kit
- PTPLUSBSK** PLUS Basic Starter Kit (without cards or readers)
- PTPLUSUG2** PassPoint PLUS Software UPGRADE
- PTASKPROX** Access Starter Kit
- PTBSK** Basic Starter Kit (without cards or readers)

ADDITIONAL EQUIPMENT

- PTDEK** Door Expansion Kit
- PTQRM** Quad Relay Module
- PTZIM** Zone Input Module
- PTVGM** Vista Gateway Module
- PTCEK** Card Enrollment Kit
- PTCANPOWER** Enclosure with power supply, suitable for up to two modules
- PTPROX** Proximity Reader
- PTPROX25** Prox. Cards (25) pcs.

Consult your Sales Representative for more information.

VGM-ADEMCO VISTA GATEWAY MODULE

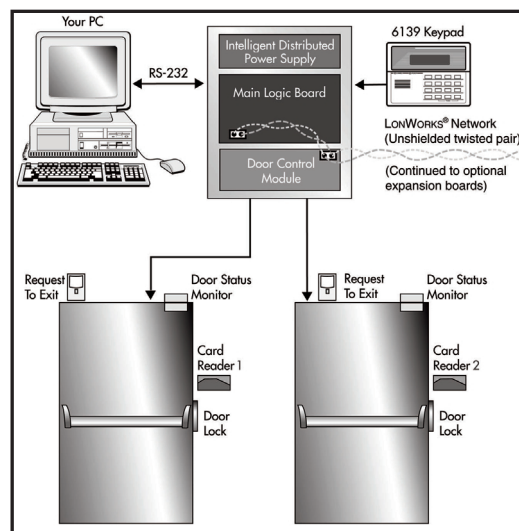
Take your Access Control installation to the next level with the integrated Fire and Burglary features of the Vista system. The VGM intelligently links the power of PassPoint with the established feature set of the Vista 128 series panels. **A tremendous business opportunity** exists by offering the flexibility to integrate these two powerful systems into one homogeneous system that is simple to program and maintain. **Imagine the potential revenues when you install a commercial Vista panel and can offer an integrated Access Control system as an add-on for your customer.**

INTEGRATION FEATURES

- Provides interactive integration between ADEMCO Vista and PassPoint Access Control
- No complex wiring between burglary and access means simple installation
- Map your access points into the Vista system
- Reduces false alarms by prohibiting access until the system is disarmed or by card swipe that will arm/disarm the system
- Use your Vista wireless key to gain access
- Transmit Access Control point contact ID codes to a central station

PLUS Access Starter Kit (PTPLUSASK) contains:

- System enclosure - including cam-lock
- Intelligent distributed power supply
- Main Logic Board (MLB)
- Door Control Module (DCM)
- Wall transformer - 18 VAC - 50 VA
- ADEMCO 6139 Keypad/Display
- Two card readers (proximity type)
- 50 Proximity cards
- PassPoint Quick-Start Guide
- Cable for PC connection, RS-232 (6' long)
- PassPoint PLUS (Windows-based) software package
- Two year warranty



CAPACITY	SYSTEM FEATURE
2000	CARD HOLDERS
7000	EVENTS
32	DOORS OF ACCESS
33	RELAY OUTPUTS
32	TRIGGER POINTS
66	ZONE INPUT POINTS
64	TIME SCHEDULES
32	HOLIDAYS
128	ACCESS GROUP LEVELS